Final Corrective Measures Study Work Plan
The Boeing Company Tract 1
Hazelwood, Missouri

Prepared for:

The Boeing Company
Environment, Health and Safety
Integrated Defense Systems
P.O. Box 516, MC S111-2491
St. Louis, MO 63166-0516

Prepared by:

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April 2010

RAM GROUP *The Risk Assessment & Management Group of Gannett Fleming, Inc.*

Transmitted by FedEx Ground

April 21, 2010

Christine Kump Mitchell, P.E.
Environmental Engineer-Permits Section
Hazardous Waste Program
Missouri DNR
7545 South Lindbergh Boulevard, Suite 720
St. Louis, MO 63125

RE: Final Corrective Measures Study Work Plan
The Boeing Company Tract 1, Hazelwood, Missouri

Dear Christine:

On behalf of the Boeing Company, enclosed is the Final Corrective Measures Study (CMS) Work Plan for the referenced site.

Please call me or Joeseph Haake if you have any questions.

Sincerely,

Atul Salhotra

Atul M. Salhotra, Ph.D.
Project Manager
RAM Group of Gannett Fleming

CC: Joseph Haake – Boeing (3 copies)
Amber Whisnant – USEPA (2 copies)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

AUL	Activity and Use Limitation
CMS	Corrective Measures Study
COC	Chemical of Concern
DTL	Default Target Level
HRC	Hydrogen Releasing Compound
IWWTP	Industrial Waste Water Treatment Plant
LNAPL	Light Non-Aqueous Phase Liquid
MCL	Maximum Contaminant Level
MDNR	Missouri Department of Natural Resources
MNA	Monitored Natural Attenuation
MRBCA	Missouri Risk-Based Corrective Action
PAH	Polycyclic Aromatic Hydrocarbon
PCE	Tetrachloroethylene
PCB	Polychlorinated Biphenyl
QAPP	Quality Assurance Project Plan
RA	Risk Assessment
RAM	Risk Assessment and Management, Inc.
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVE	Soil Vapor Extraction
TetraTech	Tetra Tech EM, Inc.
TPH	Total Petroleum Hydrocarbon
TPH-DRO	Total Petroleum Hydrocarbon-Diesel Range Organic
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

This document presents a brief overview of the approved *RCRA Facility Investigation Report for McDonnell Douglas, Hazelwood, Missouri* (MACTEC, December 2004) (RFI) and *Risk-Based Corrective Action Report, Boeing Tract 1, St. Louis, Missouri* (RAM, September 2004) and addendums (RAM, June 2009 and July 2009) (RA); and the U.S. Environmental Protection Agency Final Risk Assessment, Boeing Tract 1 Facility, St. Louis, Missouri, (Tetra Tech March 2008) for the Boeing Tract 1, Hazelwood, Missouri (site). The interim soil remediation activities conducted at the site subsequent to the RFI and risk assessment (RA) and the ground water monitoring are also presented.

The Boeing Company (Boeing) submitted a focused Corrective Measures Study (CMS) Work Plan on December 17, 2009. Missouri Department of Natural Resources (MDNR) presented review comments to the CMS Work Plan in a letter dated March 12, 2010. This document presents the final CMS work plan.. The purpose of the CMS activities is to help determine the applicability of individual remedial technologies for the site.

As part of the CMS, the following activities will be conducted:

1. The risk assessment indicated exceedences of risk to receptors due to indoor and outdoor inhalation primarily due to total petroleum hydrocarbons (TPH) in groundwater. However, in the letter dated February 4, 2010, MDNR approved alternate methodology used in the technical memorandum dated January 12, 2010 titled *"Risk Evaluation of TPH for Indoor Inhalation Pathway, Boeing Tract 1 Facility, St. Louis, Missouri"*. The result of this evaluation is that concentrations of TPH in groundwater are not volatilizing into the soil vapor at concentrations that exceed risk by the indoor inhalation pathway. Therefore, soil vapor sampling as previously discussed will not be necessary.

2. Risk will be recalculated using post remediation data for areas where (i) interim measures have been conducted, and (ii) risk exceeded based on pre-remediation data.

3. A monitoring plan will be developed to evaluate/demonstrate plume stability.

4. If the risks remain unacceptable based on items 1 and 2 above, remedial measures will be selected based on regulatory approved criteria as discussed in the body of this document.

5. The proposed land use restrictions will be finalized as a part of the CMS.

1.1 BACKGROUND AND OBJECTIVE OF STUDY

The Missouri Department of Natural Resources (MDNR) and The United States Environmental Protection Agency (USEPA) approved the *Risk-Based Corrective Action Report, Boeing Tract 1* (RAM, September 2004) and addendums (RAM, June 2009 and July 2009) in a letter dated August 24, 2009 (Appendix A). In that letter the MDNR and USEPA (agencies) requested that The Boeing Company (Boeing) progress to the Corrective Action process and prepare a Corrective Measures Study (CMS) Work Plan.

Previous to the approval of the risk assessments, on December 22, 2004 MDNR approved the *Resource Conservation and Recovery Act Facility Investigation (RFI) Report* (MACTEC, December 2004). Subsequent to the approval of the RFI, in 2005 interim actions involving excavation and off-site disposal of soil were conducted.

This document presents the Work Plan for the CMS prepared in accordance with Section VII, *CMS Work Plan of the Missouri Hazardous Waste Management Facility Part I Permit* and is consistent with the guidance contained in the USEPA document *RCRA Corrective Action Plan (Final), May 1994, OSWER Directive 9902.3-2A.*

The objective of the CMS Work Plan is to present the procedures to be used during the CMS to identify, evaluate, and propose the necessary remedial alternatives to address the specific areas that present an unacceptable risk. Areas where risk is acceptable will not be evaluated further. In addition, the site-wide groundwater impacts will be evaluated to ensure the plume is stable or decreasing. The purpose of the CMS activities is to help determine the applicability of individual remedial technologies for the site.

1.2 CHRONOLOGY OF RELEVANT ACTIVITIES

There have been numerous investigations at the facility including a RFA, UST removals/investigations, and environmental assessments and investigations. These previous assessments/investigations culminated in the approved RFI.

1.2.1 Resource Conservation and Recovery Act (RCRA) Facility Investigation Report (RFI)

The RFI was prepared by MACTEC Engineering and Consulting, Inc. dated December 2004. The objectives of the RFI were to:

- Determine the nature and extent of impact to the study areas,
- Determine the physical properties and characteristics of the affected media, and
- Obtain the necessary data to support the risk assessment and CMS.

The RFI divided the facility into 18 study areas based on the results of the previous assessments, investigations, and interim measures. The geology and hydrogeology are characterized in the RFI. Aquifer testing was performed and soil samples were collected for analysis of geotechnical parameters. Several soil borings were advanced and temporary piezometers, permanent piezometers, and monitoring wells were installed (MACTEC Table 3-1, December 2004 presents a listing of the monitoring wells). Soil and groundwater samples were collected, field parameters measured, and samples analyzed in the laboratory. Samples were analyzed using approved laboratory methods for one or more of the following constituents:

- Volatile organic compounds (VOCs),
- Polynuclear aromatic hydrocarbons (PAHs),
- Polychlorinated biphenyls (PCBs),
- Total and dissolved metals, and
- TPHs.

The primary conclusion of the RFI was that (i) the impacts to soil and groundwater have been adequately identified and delineated, and (ii) the impacts are confined to the facility and do not extend offsite or cross from the North Tract to the South Tract or vice versa.

The data collected in the RFI were used in the subsequent risk assessments.

1.2.2 Risk Assessments

Two risk assessments were performed:

- Risk-Based Corrective Action Report, Boeing Tract 1, St. Louis, Missouri, dated September 2004, and addendums dated June 2, 2009 and July 24, 2009, prepared by Risk Assessment & Management Group, Inc. (RAM).

- Final Risk Assessment, Boeing Tract 1 Facility, St. Louis, Missouri, dated March 2008, was prepared by Tetra Tech EM, Inc. (TetraTech) for the USEPA.

1.2.2.1 RAM Risk Assessment

The RAM risk assessment divided the facility into 23 Areas and Sub-areas, each characterized by similarities in factors that affect human health under reasonable current and future land use conditions (Table 1-1 and Figure 1-1). The soil and groundwater data set compiled for use in the RA was from the RFI. The receptors, pathways, and complete routes of exposure for current and future land use were identified for each Area/Sub-area.

The large number of constituents analyzed in soil and groundwater were screened to identify the constituents of concern (COCs) for which quantitative risks were evaluated. Constituents that were non-detect in a media were eliminated from that media. The list of COCs for each Area/Sub-area based on all media and all receptors is presented in Table

1-2.

The risk evaluation consisted of calculating risk for each receptor in each Area/Sub-area using the Missouri Risk-Based Corrective Action (MRBCA) process. The cumulative risk for each receptor in each Area/Sub-area is summarized on Table 1-3. Further, the risk evaluation identified the potential impacts to Cold Water Creek and concluded the absence of any ecological risks.

The cumulative risk exceeded the regulatory acceptable level for carcinogens and /or for non-carcinogens in Sub-areas 2A, 2B, 3A, 3C, 3E, 3G, 6B, 6C, and 8B (Figure 1-1).

1.2.2.2 Tetra Tech Risk Assessment

Before accepting the results of the RAM risk assessment, the USEPA asked Tetra Tech to perform a RA of selected areas using the USEPA Risk Assessment Guidance for Superfund (RAGS) protocols. The Tetra Tech RA focused on Sub-areas 2C, 3F, 3H, and 6B.

Unacceptable exposures were identified for the construction worker and outdoor worker due to groundwater impacts in Sub-areas 2C, 3H, and 6B. Tetra Tech also indicated that arsenic was unacceptable to the outdoor worker as a non-carcinogenic hazard in Subarea 6B soil; however, their calculations did not indicate an exceedence.

1.2.3 Additional Investigations and Interim Actions

Since the completion of the RFI and risk assessment, interim remedial measures and groundwater monitoring have been conducted as discussed below.

1.2.3.1 Interim Action Remedial Excavation Completion Report, Boeing Tract 1 (MACTEC, May 2006)

Based on the RAM Group risk assessment, there was an unacceptable risk at four locations based on TPH-Diesel Range Organics (DRO) with impact limited to single soil borings (Risk Areas 6B, 3A, 3E, and 8B). These exceedences were based on the future exposure pathway of volatilization from groundwater to indoor air. Additionally, an unacceptable risk for benzo(a)anthracene was present in Risk Area 6B based on the future exposure pathway of direct contact with groundwater by a construction worker.

As an interim action, impacted soil was excavated at each of these areas in 2005 and disposed off-site. The mass of soil excavated from each sub-area is shown in Table 1-4. The objective was to remove impacted soil that could be a source for shallow groundwater impacts. Table 1-4 shows the soil samples used in previous risk calculations that were collected in soil excavated as part of the interim action and hence removed. As a part of developing this CMS Work Plan, RAM Group has recalculated the representative soil concentrations for these Sub-areas (6B, 3A, 3E, and 8B) not including the soil concentrations for samples removed during the excavations. As expected a few

the representative soil concentrations decreased and some increased. Table B-1 in Appendix B shows the recalculated representative soil concentrations and comparison to pre-interim action representative concentrations.

Carcinogenic and non-carcinogenic risks calculated with the updated representative soil concentrations is also presented in Appendix B (Tables 4A-10(a), 4A-10(b), 4E-10(a), 4E-10(b), 7B-10(a), 7B-10(b), and 9B-11(b)). As expected, the calculated risks are different, however there is no change in the overall risk management decision.

The following piezometers were installed in each interim action area and groundwater samples were collected and analyzed once prior to and twice after completing the interim action excavations.

- Sub-area 6B – RC13, RC14, and RC15
- Sub-area 8B – B220N4, B220N5, and B220N6
- Sub-area 3A – B42N6, B42N7, and B42N8
- Sub-area 3E – B2E3, B2E4, and B2E5

COCs that exceeded risk (benzo(a)anthracene at Sub-area 6B and TPH-DRO at Sub-areas 3A, 3E, 6B, and 8B) were not detected in any of the groundwater samples analyzed from the four Sub-areas during the two post excavation sampling events; therefore, additional groundwater sampling was not recommended by MACTEC. Copies of the post-interim action groundwater analytical tables from the MACTEC report are provided in Appendix C.

1.2.3.2 Interim Measure Completion Report, Solid Waste Management Unit 17 (MACTEC, June 2006)

Based on the RAM risk assessment, there was an unacceptable risk for tetrachloroethylene (PCE) at SWMU 17 (Risk Area 2B) based on dermal contact with groundwater by a future construction worker.

As an interim action, impacted soil was excavated in 2005 from SWMU 17 and disposed off-site. The mass of soil excavated from Sub-area 2B was approximately 2,073 tons (Table 1-4). The objective was to remove impacted soil that could be a source for shallow groundwater impacts. The excavation was dewatered during excavation and the water stored in temporary tanks onsite until characterized for disposal. Based on the characterization results, the water was disposed at the Boeing Industrial Waste Water Treatment Plant (IWWTP). About 8,000 lbs of Hydrogen Release Compound (HRC) was added to the floor of the excavation. Groundwater samples were collected and analyzed from nearby piezometers and monitoring wells prior to the interim action excavation. Three piezometers and a monitoring well (TP-1, TP-2, B51I1, and MW-7S) were removed during the excavation and were not replaced.

A 4-inch diameter stainless steel well screen was placed in the southeast corner of the excavation to a depth of 10 ft to act as a backfill observation well (SWMU17-OB-1). No

post excavation groundwater sampling was performed as part of the interim action measure.

Table 1-4 shows the soil samples used in previous risk calculations that were removed by this interim action. RAM Group has recalculated the representative soil concentrations for this Sub-area (2B) not including the previous soil concentrations for samples that have been removed during the excavations. As expected, the representative soil concentrations decreased and some increased. Table B-1 in Appendix B shows the recalculated representative soil concentrations and comparison to pre-interim action representative concentrations. Recalculation of risk with the updated representative soil concentrations is also presented in Appendix B (Tables 3B-12(a) and 3B-12(b)). Although, the calculated risks are different, there is no change in the overall risk management decision.

1.2.3.3 RAM Group Groundwater Sampling – November 2008 with reports in 1/09, 5/09, and 6/09

RAM Group performed a reconnaissance of available monitoring wells at the Boeing facility on July 29-30, 2008 and performed low-flow purging and groundwater sampling on November 17-21, 2008. The following reports and memoranda were submitted to the MDNR based on the results of this sampling event:

- *November 2008 Groundwater Sampling Data Compilation Report, Boeing Tract 1, Hazelwood, Missouri,* dated January 16, 2009, prepared by RAM.

  This report is an inventory of the data collected during the field activities to locate accessible wells, development of the wells, purging and sampling, and the laboratory analysis of data from 57 monitoring wells.

- *Changes in Groundwater Concentrations per November/December 2008 Sampling Event, Boeing Tract 1, St. Louis, Missouri*, Memorandum date May 8, 2009, prepared by RAM.

  This memo compared the November 2008 groundwater data for each well sampled to the previous sampling event data for that well. There was no clear trend from the previous sampling events. However, for wells that had detectable concentrations during both events, most but not all concentrations decreased. Trace LNAPL levels were noted in 7 of the 57 wells gauged and only one well showed an increase in thickness (MW-10S from 0.01 to 0.05 ft. Free product was observed in only three Sub-areas (1, 2B, and 2C).

- *Groundwater Flow Gradient – Shallow and Deep Groundwater Zones, November 17-19, 2008 Gauging, Boeing Tract 1, St. Louis, Missouri*, Memorandum dated June 4, 2009, prepared by RAM.

  This memo documented the horizontal flow gradients for the shallow and deep

groundwater zones, as well as the vertical gradient between the zones based on the November 2008 gauging data. Of the 57 wells gauged (48 shallow, 3 intermediate, 5 deep, and 1 backfill), the average groundwater depths from top of casing (toc) were 5.6 ft for shallow wells, 7.3 ft for intermediate wells, and 12.9 ft for deep wells.

The average horizontal groundwater flow gradients were to the east at 0.01 ft/ft for the shallow zone and to the south and southeast at 0.009 ft/ft in the deep zone.

The vertical flow gradients between the shallow and deep zones were downward in Sub-areas 2B, 3D, and 8A (0.019 to 0.294 ft/ft), and upward in 6B, 6C, and 6D (0.018 to 0.135 ft/ft).

The vertical flow gradients between the shallow and intermediate zones were variable ranging from 0.011 ft/ft upward to 0.115 ft/ft downward in Sub-area 2B.

The vertical flow gradient between the intermediate and deep zones was downward in Sub-area 2B at a gradient of 0.539 ft/ft.

The results were consistent with the RFI Report for gauging data collected in August and December 2002 and March and June 2003.

SECTION 2.0
APPROACH FOR INVESTIGATION AND EVALUATION OF POTENTIAL REMEDIES

2.1 GENERAL APPROACH

Table 2-1 presents the eleven Sub-areas with risk and hazard exceedences based on the combined results of the RAM Group and Tetra Tech risk assessments. The table also shows the COCs primarily causing the exceedences and the routes of exposure. These exceedences will be addressed by the CMS.

2.1.1 Re-evaluation of Risks

The previous risk assessments were based on groundwater data collected up to 2004. Additional groundwater data has been collected in 2005 as part of the soil interim action excavations and in November 2008 during a site-wide groundwater sampling event. As appropriate, representative groundwater concentrations will be recalculated to include the data collected since 2004 and may be used to estimate risk related to the groundwater pathway, if necessary. Additionally, recalculated representative groundwater concentrations will be used to demonstrate plume stability. Any Sub-areas with unacceptable risks will be addressed in the CMS.

As appropriate, the results of these activities that will help facilitate selection of the final remedy will be documented in interim reports and submitted to the agencies for their review and approval prior to finalizing the CMS.

2.1.2 Treatment of Total Petroleum Hydrocarbons (TPH)

Eleven Sub-areas (2A, 2B, 2C, 3A, 3C, 3E, 3G, 3H, 6B, 6C, and 8B) were identified with unacceptable risks due to exposures related to groundwater impacts. In all of those Sub-areas, TPH concentrations in groundwater presented an unacceptable risk to workers due to either indoor or outdoor inhalation of vapors from groundwater. As a part of developing the CMS work plan, RAM Group on behalf of Boeing, determined that these exceedences are an artifact of the methodology, and the assumptions used to calculate the indoor inhalation risk for TPH. Specifically, the representative ground water concentrations of several carbon fractions constituents of TPH used to estimate the risk exceeded their solubility levels. Further, the calculated vapor concentrations exceeded the saturated vapor concentrations. This is thermodynamically incorrect and hence the calculated indoor risks were over estimated. This information was presented in detail in a technical memorandum prepared by RAM Group on behalf of Boeing, and submitted to MDNR on January 12, 2010. MDNR reviewed this memorandum and documented their concurrence in their response dated February 4, 2010. Both these documents are included in Appendix F.

The result of this evaluation is that concentrations of TPH in groundwater are not volatilizing into the soil vapor at concentrations that exceed risk to the indoor inhalation

pathway. Also, in Sub-areas 2C, 3H, and 6B unacceptable inhalation risks were calculated due to benzene, mercury, 1,2-dichloroethene (total), trichloroethene, and vinyl chloride in groundwater.

Therefore, Boeing will re-evaluate the remaining inhalation risks due to benzene, mercury, 1,2-dichloroethene (total), trichloroethene, and vinyl chloride including post 2004 groundwater data for Sub-areas 2C, 3H, and 6B.The results will be used to recalculate representative soil vapor concentrations for each Sub-area. The representative concentrations will be used to estimate indoor and outdoor vapor concentrations using models and site specific soil geotechnical parameters and building and pavement characteristics. The representative indoor and outdoor vapor concentrations will be used to recalculate risk to the affected workers.

Any Sub-areas with unacceptable risks will be addressed by the CMS and alternative remedial actions will be evaluated.

2.1.3 Plume Stability and Monitored Natural Attenuation (MNA)

Plume stability and natural attenuation will be evaluated by the CMS using the updated groundwater database that includes the groundwater data collected since 2004. For Sub-areas that present unacceptable risks based on the recalculations discussed above in Sections 2.1.1 and 2.1.2 and / or do not show a stable or decreasing plume, an on-going groundwater monitoring plan will be developed.

The groundwater monitoring plan will use monitoring wells and piezometers selected from the 57 currently available for use. The monitoring plan will include the following:

- specific wells / piezometers to be sampled,
- frequency of sampling,
- specific chemicals to be analyzed and methods,
- reporting criteria,
- comparison of the results with the MCLs, and where MCLs are not available, then the Regional Screening Levels, and if not available, then the MRCBA DTLs, and
- expected term of sampling.

Groundwater monitoring will be conducted per the approved Quality Assurance Project Plan (QAPP). Comparison with these criteria does not imply that they are being adopted as the clean-up levels. The clean-up levels will be established based on site specific considerations and updated risk evaluation as data is collected.

Plume stability will be evaluated using qualitative and statistical tools. The qualitative tools will include concentration vs. time plots , concentr ation vs. distance plots, and concentration contour maps over various time periods. The statistical tools will include the Mann Kendall test and possibly regression analysis. It is not anticipated that quantitation tools will be used, such as the mass flux, center of mass, or total mass in plume approaches. Determination of plume stability will be in accordance with USEPA

(1998, 2004) Section 6.13.2 of the Departmental MRBCA Guidance Document (MDNR, April 2006, Updated June 2006 and June 2008) and other relevant publically available literature. Alternatives may be evaluated for use in hastening plume stability.

Monitored natural attenuation (MNA) will be one of the alternatives considered for some Sub-areas. An MNA plan will be prepared that will identify the specific wells/ piezometers to be included, the specific parameters to be analyzed in the field and in the laboratory, the frequency of sampling, and the evaluation and reporting criteria to be used. The occurrence and rate of natural attenuation will be determined in accordance with Section 6.8.4 of the Departmental MRBCA Guidance Document (MDNR, April 2006, Updated June 2006 and June 2008), likely using primary and secondary lines of evidence.

The monitoring wells and piezometers, a total of 57 listed in the following table are available for sampling. The locations of these wells/piezometers are shown on Figure 1-2. The screened intervals are as follows:

- Backfill - 0-10 ft bgs
- Shallow zone – 2-26 ft bgs
- Intermediate zone – 32-42 ft bgs
- Deep zone – 56-80.5 ft bgs

Wells / Piezometers Available for Sampling

Backfill	**Shallow Zone**	**Shallow Zone**	**Shallow Zone**
SWMW17-OB-I	B4MW-9	MW-9S	RC14
Shallow Zone	MW1	MW-A1	RC8D
B220N4	MW10S	MW-A12	TP-3
B220N6	MW-10S	MW-A13	TP-4
B25MW1	MW-11S	MW-A15	TP-6
B27W3D	MW3	MW-A16	**Intermediate Zone**
B28MW3	MW4	MW-A22	MW-11I
B28MW4	MW5CS	MW-A23	MW-5I
B2E3	MW5DS	MW-A25	MW-8I
B2E5	MW6	MW-A26	**Deep Zone**
B41MW-18	MW-6S	MW-A27	B41S5D
B41MW-5	MW7	MW-A29	MW10D
B42N6	MW8AS	MW-A3	MW-11D
B48N1	MW-8S	MW-A4	MW6D
B4MW-10	MW9S	MW-A8	MW8AD

We believe there are sufficient piezometers and monitoring wells to develop a monitoring plan for the evaluation of plume stability and MNA. However, if additional wells are necessary, wells will be installed.

2.1.4 Activity and Use Limitations (AULs)

Boeing is working with the agencies on acceptable activity and use limitation language, documentation, and recordation. The AULs will be in accordance with Section 11 and Appendix J of the Departmental MRBCA Guidance Document (MDNR, April 2006, Updated June 2006 and June 2008) and the Missouri Environmental Covenants Act and will be used to prevent future use of groundwater at the facility for potable purposes and will restrict future use of the facility to commercial purposes. The AULs will be durable, reliable, and enforceable. The proposed AUL language is presented in Appendix D.

2.2 EVALUATION AND SELECTION OF REMEDIAL ALTERNATIVES

Based on the results of the activities presented in Section 2.1 (additional data collection and evaluation), some Sub-areas with remaining unacceptable risks may require additional actions and possibly active remediation. Remedial alternatives will be evaluated for these areas.

A preliminary evaluation of the proposed remedial alternatives will be performed using the following criteria:

1. Protect human health and the environment;
2. Attain media cleanup standards;
3. Control of sources of releases; and
4. Comply with any applicable standards for management of wastes.

The following five decision factors will be considered in the selection process for the proposed remedy:

1. Long-term reliability and effectiveness;
2. Reduction in the toxicity, mobility, or volume of wastes;
3. Short-term effectiveness;
4. Implementability; and
5. Cost.

The following remedial options will be considered:

2.2.1 Remedial Options to Address Vapor Risk

Feasible remedial alternatives will be identified and evaluated on an area-specific basis to determine the recommended remedial alternative(s).

The following remedial options may be considered:

- In-situ bioremediation (for low molecular weight organics)
- Air sparging with soil vapor extraction (SVE)
- Chemical oxidation
- Precipitation/Co-precipitation (for mercury only)

- Ion Exchange (for mercury only)
- Monitored natural attenuation (MNA)
- Pump and treat
- Mobile enhanced multiphase extraction (for Sub-areas 2B and 2C with trace light non-aqueous phase liquid (LNAPL) present)

2.2.2 Remedial Options to Address Plume Stability (LNAPL)

In addition, if the groundwater plume is not stable due to the presence of trace LNAPL, the following remedial options will be considered:

- Mobile enhanced multi-phase extraction
- Passive free product recovery

This applies only to Area 1 and Sub-areas 2B and 2C.

2.2.3 Remedial Options to Address Plume Stability (non-LNAPL sources)

If groundwater concentrations are not stable due to reasons other than LNAPL, then the remedial alternatives in Section 2.2.1 will be considered. Note this applies to the entire site.

2.3 RISK MANAGEMENT PLAN

The CMS result will be to identify any Sub-areas with remaining unacceptable risk, recommend alternatives to address those specific issues, develop media-specific clean-up levels, and develop a risk management plan to present the steps and schedule needed to implement the corrective action. The Risk Management Plan will be prepared in accordance with Section 12 of the Departmental MRBCA Guidance Document (MDNR, April 2006, Updated June 2006 and June 2008).

2.4 CMS PROJECT SCHEDULE

Upon approval of this work plan and an outline of the CMS report, a CMS project schedule will be developed to meet Boeing and agencies schedule.

2.5 PERSONNEL

The key personnel that will be involved in the CMS are as follows:

- Atul M. Salhotra, Ph.D. – Project Manager and Principal Professional
- Cliff W. Wright, P.E. – Senior Engineer and Missouri Professional Engineer
- Sungmi Moon, Ph.D. – Senior Engineer
- Kendall L. Pickett – Senior Geologist

Resumes for the above personnel are available upon request.

Additional support engineers, scientists, and administrative personnel in RAM Group's Houston and St. Louis offices will be utilized on an as needed basis.

1. MACTEC Engineering and Consulting, Inc. (MACTEC). *2004. RCRA Facility Investigation Report for McDonnell Douglas, Hazelwood, Missouri*, dated December.

2. MACTEC. 2006. *Interim Action Remedial Excavation Completion Report, Boeing Tract 1, McDonnell Douglas, Hazelwood, Missouri*, report dated May.

3. MACTEC. 2006. *Interim Measure Completion Report, Solid Waste Management Unit 17, McDonnell Douglas, Hazelwood, Missouri*, report dated June.

4. Missouri Department of Natural Resources (MDNR). 1997. *McDonnell Douglas' Missouri Hazardous Waste Management Facility Part I Permit MOD 000818963*, dated March 5.

5. MDNR. 2006, 2008. *Departmental Missouri Risk-Based Corrective Action (MRBCA) Technical Guidance*, dated April 2006, updated June 2006 and June 2008).

6. MDNR. 2009. Risk-Based Corrective Action Report, Boeing Tract 1 Dated September 2004, Addendums to Risk-Based Corrective Action Report Dated June 29, 2009, and Dated July 29, 2009, The Boeing Company, Hazelwood, Missouri, EPA ID# MOD000818963, letter dated August 24.

7. Missouri General Assembly. 2008. *Missouri Environmental Covenants Act.* Missouri Revised Statues, Chapter 260, Environmental Control, Sections 260.1000 – 260.1039, Effective January 1, 2008.

8. Risk Assessment & Management Group, Inc. (RAM). 2004. *Risk-Based Corrective Action Report, Boeing Tract 1, St. Louis, Missouri*, dated September.

9. RAM Group of Gannett Fleming, Inc. (RAM Group). 2009. *November 2008 Groundwater Sampling Data Compilation Report, Boeing Tract 1, Hazelwood, Missouri,* dated January 16.

10. RAM Group. 2009. *Changes in Groundwater Concentrations per November/December 2008 Sampling Event, Boeing Tract 1, St. Louis, Missouri*, Memorandum dated May 8.

11. RAM Group. 2009. *Groundwater Flow Gradient – Shallow and Deep Groundwater Zones, November 17-19, 2008 Gauging, Boeing Tract 1, St. Louis, Missouri*, Memorandum dated June 4.

12. RAM Group. 2009. *Revised Addendum A Protection of Surface Water*, addendum to risk assessment dated June 4.

13. RAM Group. 2009. *Effect of Changes in Toxicity Values and Exposure Factors on Risks, Response to Outstanding Comment on Boeing RBCA Report Dated September 2004, Hazelwood, Missouri*, addendum to risk assessment dated July 24.

14. Tetra Tech EM, Inc. *(Tetra Tech). 2008. U.S. Environmental Protection Agency Final Risk Assessment, Boeing Tract 1 Facility, St. Louis, Missouri*, report dated March.

15. United States Environmental Protection Agency (USEPA). 1994. *RCRA Corrective Action Plan (Final),* OSWER Directive 9902.3-2A, dated May.

- U.S. EPA. 1998. Technical protocol for evaluating natural attenuation of chlorinated solvents in ground water. EPA/600/R-98/128. Cincinnati, Ohio: National Risk Management Research Laboratory.

- U.S. EPA. 2004. Performance monitoring of MNA remedies for VOCs in ground water. EPA/600/R-04/027. Cincinnati, Ohio: National Risk Management Research Laboratory.

TABLES

FIGURES

Appendix A

Agencies Approval of RAM Group Risk Assessment Letter Dated August 24, 2009

Appendix B
Post-Interim Action Representative Soil Concentrations and Recalculation of Risks

Appendix C
Post-Interim Action Groundwater Concentrations

Appendix D
Proposed AUL Language

Appendix E
Agencies Review Comments on the CMS Work Plan Submitted on December 17, 2009

Appendix F
Technical Memorandum: Risk Evaluation of TPH for Indoor Inhalation Pathway (January 12, 2010) and MDNR's Response Dated February 4, 2010.

Table 1-1
Approved Risk Assessment Exposure Areas
Boeing Tract 1, Hazelwood, Missouri

AREA	SUB-AREA	DESCRIPTION
Area 1		Runway Protection Zone: (includes former Buildings 40, 45L, 45C, 45D, 45E, and parts of 45 and 45K).
Area 2		Demolished Area: (includes former Buildings 45J, 51, 52, 48, 48A, and part of 45K).
	Sub-area 2A	Western portions of Buildings 45J, 51, and 52, northwestern corner of Building 45, northern portion of Building 45K, and parking lots, entrance road, and open space between these buildings and the west property line.
	Sub-area 2B	Eastern portion of Buildings 45J, 51, and 52, northwestern portion of Building 45, western portions of Buildings 48 and 48A, smaller associated buildings, and associated parking lots and access areas.
	Sub-area 2C	Eastern portions of Buildings 48 and 48A, northeastern portion of Building 45, smaller associated buildings, and associated parking lots and access areas.
Area 3		Retained Area: (includes Buildings 42, 43, 45H, 41, 44, 44A, 46, 49, 1, 2, 3, and 4).
	Sub-area 3A	Buildings/structures 44, 44A, 46, and 49, western portion of Building 41, northern edge of Building 42, and associated parking lots and access areas primarily to the west and south of these buildings.
	Sub-area 3B	Small open area between Buildings 2 and 42 including the parking access area on the western side of Building 2.
	Sub-area 3C	All but the northern edge of Building 42, several buildings/structures to the south of Building 42, and associated paved parking and access areas primarily to the east and south of these buildings to the runway on the south.
	Sub-area 3D	Eastern portion of Buildings 41, northern half of Building 2, and the associated open and parking areas on the west side of Building 2.
	Sub-area 3E	Small open area between Buildings 2 and 4 including parking and access areas.
	Sub-area 3F	Small rectangular area at the southwestern corner of Building 1, including parking and access areas and the southwest corner of Building 1.
	Sub-area 3G	Small rectangular area between Buildings 1, 2, and 3, including parking and access areas and the northeastern portion of Building 1 and the northwestern portion of Building 3.
	Sub-area 3H	Building 4 and the open access areas to the north, east, and south sides of the building.
Area 4		Power Plant: (includes Buildings 5 and 6).
Area 5		Industrial Water Treatment Plant: (includes Building 14).
Area 6		GKN Facility: (includes Buildings 21, 22, 25, 27, 28, 29, 29A, and 39).
	Sub-area 6A	Buildings 21, 29, and 29A, and all parking lots and open space to the south and west of these buildings.
	Sub-area 6B	The area between Buildings 29 and 27, containing Buildings 22, 28, 39.
	Sub-area 6C	Buildings 25 and 27 and parking lots and open space to the south of these buildings and within about 450 feet to the east.
	Sub-area 6D	Parking lots and open areas beginning about 450 feet east of Buildings 25 and 27 and extending to the north, south, and east property lines.
Area 7		Engineering Campus: (includes Buildings 27A, 32, 33, and 34).
Area 8		Office Complex North: (includes Buildings 220 and 221).
	Sub-area 8A	Southern portion of Building 220, associated parking areas to the south and access areas to the east.
	Sub-area 8B	Northern portion of Building 220 and the open area to the northwest of the building to the property boundary including smaller associated buildings, parking areas, and unpaved areas along the property boundary.
	Sub-area 8C	Building 221 and the associated parking and access areas to the north, east, and west of the building.
Area 9		Gun Range: (includes Buildings 10, 11, 11A, 12, and 13).

Table 1-2
Approved Chemicals of Concern (COCs)
RAM Group Risk Assessment
Boring Tract 1, Hazelwood, Missouri

COCs	Area 1	Sub-area 2A	Sub-area 2B	Sub-area 2C	Sub-area 3A	Sub-area 3B	Sub-area 3C	Sub-area 3D	Sub-area 3E	Sub-area 3F	Sub-area 3G	Sub-area 3H	Area 4	Area 5	Sub-area 6A	Sub-area 6B	Sub-area 6C	Sub-area 6D	Sub-area 8A	Sub-area 8B	Sub-area 8C	Area 9
1,1-Dichloroethane																X						
1,1-Dichloroethene			X					X								X						
1,1,2-Trichloro-1,2,2-trifluoroethane																X						
1,2,3-Trimethylbenzene	X		X													X						
1,2,4-Trimethylbenzene	X		X		X			X	X		X					X						
1,3,5-Trimethylbenzene					X			X			X											
2-Hexanone																	X					
Acetone	X		X			X	X		X		X	X	X		X	X	X		X		X	X
Benzene	X	X	X	X	X	X	X	X	X		X				X	X						
Bromomethane																X						
Carbazole													X									
Carbon disulfide						X																
Chloroethane			X					X														
Chloroform																	X					
cis-1,2-Dichloroethene			X		X											X	X		X			
Dichlorodifluoromethane		X														X	X	X				
Ethylbenzene	X	X	X	X	X	X		X	X		X					X	X					
Isopropylbenzene			X		X	X	X	X	X													
m,p-Xylene			X		X			X	X		X											
Methylene chloride		X	X	X	X		X		X			X	X			X			X			X
Methyl ethyl ketone			X									X	X		X	X	X	X	X	X		
Methyl isobutyl ketone																	X					
Methyl tert-butyl ether			X				X		X		X					X						
Naphthalene			X						X		X											X
n-Butylbenzene			X				X	X	X													
n-Propylbenzene	X		X		X	X	X	X	X													
o-Xylene			X					X			X						X					
p-Isopropyltoluene			X		X			X			X											
sec-Butylbenzene			X		X	X	X	X	X													
tert-Butylbenzene							X	X														
Tetrachloroethene		X	X					X								X		X			X	
Toluene	X	X	X	X	X	X	X		X		X		X			X		X	X			X
trans-1,2-Dichlorobenzene																X						
trans-1,2-Dichloroethene			X													X						
Trichloroethene		X	X					X								X	X		X			
Vinyl chloride			X		X			X								X	X		X			
Xylenes, Total	X	X	X	X	X	X	X	X	X		X	X	X			X	X					
Aroclor 1254																X						
Acenaphthene																X						
Acenaphthylene																X						
Anthracene													X									
Benzo(a)anthracene													X			X	X					
Benzo(a)pyrene								X					X									
Benzo(b)fluoranthene													X			X	X			X		
Benzo(g,h,i)perylene													X									
Benzo(k)fluoranthene													X									
Chrysene													X		X	X	X			X		
Dibenzo(a,g)anthracene													X									
Fluoranthene													X			X	X					
Fluorene																X						
Indeno(1,2,3-cd)pyrene													X									
Phenanthrene													X			X						
Pyrene													X			X						
Total Organics	**8**	**8**	**25**	**5**	**14**	**9**	**11**	**19**	**14**	**0**	**12**	**4**	**18**	**0**	**4**	**31**	**16**	**4**	**7**	**3**	**2**	**4**

Table 1-2
Approved Chemicals of Concern (COCs)
RAM Group Risk Assessment
Boring Tract 1, Hazelwood, Missouri

COCs	Area 1	Sub-area 2A	Sub-area 2B	Sub-area 2C	Sub-area 3A	Sub-area 3B	Sub-area 3C	Sub-area 3D	Sub-area 3E	Sub-area 3F	Sub-area 3G	Sub-area 3H	Area 4	Area 5	Sub-area 6A	Sub-area 6B	Sub-area 6C	Sub-area 6D	Sub-area 8A	Sub-area 8B	Sub-area 8C	Area 9
Aliphatics > nC6 to nC8 (TX1006)			X			X			X		X					X	X			X		
Aliphatics > nC8 to nC10 (TX1006)			X			X			X		X					X	X			X		
Aromatics > nC8 to nC10 (TX1006)			X			X			X		X					X	X			X		
TPH-GRO	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
Aliphatics > nC10 to nC12 (TX1006)			X			X			X		X					X	X			X		
Aliphatics > nC12 to nC16 (TX1006)			X			X			X		X					X	X			X		
Aliphatics > nC16 to nC21 (TX1006)			X			X			X		X					X	X			X		
Aromatics > nC10 to nC12 (TX1006)			X			X			X		X					X	X			X		
Aromatics > nC12 to nC16 (TX1006)			X			X			X		X					X	X			X		
Aromatics > nC16 to nC21 (TX1006)			X			X			X		X					X	X			X		
TPH-DRO	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
Aliphatics > nC21 to nC35 (TX1006)			X			X			X		X					X	X			X		
Aromatics > nC21 to nC35 (TX1006)			X			X			X		X					X	X			X		
TPH-ORO	X	X	X	X	X	X	X	X	X	X	X	X	X					X				X
Total TPH	**3**	**3**	**14**	**3**	**3**	**14**	**3**	**3**	**14**	**3**	**14**	**3**	**3**	**2**	**2**	**13**	**13**	**3**	**0**	**11**	**2**	**3**
Aluminum																						
Antimony	X	X	X													X						
Arsenic	X	X	X		X			X				X	X	X	X	X	X	X	X	X		X
Barium								X							X	X	X		X			X
Beryllium	X	X	X					X								X						X
Cadmium		X	X					X							X	X	X					X
Chromium			X					X						X	X	X	X	X	X	X		X
Chromium, hexavalent																	X					
Cobalt	X	X	X													X						
Copper	X	X	X					X								X						X
Cyanide, total														X								
Manganese	X		X					X				X	X			X			X			X
Mercury	X	X	X		X									X		X	X		X	X		X
Nickel	X	X	X					X						X		X						X
Selenium	X		X					X					X	X	X	X	X					X
Silver			X																			X
Thallium			X					X														
Vanadium																						
Zinc		X	X					X								X						X
Total Metals	**9**	**9**	**14**	**0**	**2**	**0**	**0**	**11**	**0**	**0**	**0**	**2**	**3**	**6**	**5**	**13**	**7**	**2**	**5**	**3**	**0**	**12**
TOTAL COCs	**20**	**20**	**53**	**8**	**19**	**23**	**14**	**33**	**28**	**3**	**26**	**9**	**24**	**8**	**11**	**57**	**36**	**9**	**12**	**17**	**4**	**19**

Notes:
X: COC
C: carbon range
TPH: total petroleum hydrocarbons
GRO: gasoline range hydrocarbons
DRO: diesel range hydrocarbons
ORO: oil range hydrocarbons
Area 7 - No risk calculation was performed since there is only one sample location and no industrial activities.

Table 1-3
Summary of Cumulative Risks*
Boeing Tract 1, Hazelwood, Missouri

Area	Non-residential Worker		Construction Worker	
	IELCR	HI	IELCR	HI
Area 1 (Max.)	N/A	N/A	6.34E-07	0.50
Sub-area 2A	5.97E-08	**22**	3.52E-07	0.31
Sub-area 2B	7.57E-06	**96**	1.89E-05	**3.1**
Sub-area 2C	2.02E-08	0.95	3.92E-08	0.047
Sub-area 3A	7.90E-08	**2.6**	4.52E-08	0.055
Sub-area 3B	3.35E-09	0.31	4.66E-10	0.0071
Sub-area 3C	2.00E-08	**77**	2.34E-08	**1.3**
Sub-area 3D	2.93E-08	0.075	1.17E-07	0.048
Sub-area 3E	4.31E-08	**10**	8.02E-10	0.12
Sub-area 3F	NA	0.86	NA	0.0082
Sub-area 3G	6.02E-08	**2.8**	9.38E-08	0.12
Sub-area 3H	NA	0.70	6.35E-13	0.0058
Area 4	2.17E-10	0.47	2.60E-06	0.014
Area 5	NA	0.00053	6.37E-08	0.013
Sub-area 6A	1.12E-10	0.054	5.33E-08	0.0089
Sub-area 6B	1.44E-06	**7.9**	2.44E-05	0.17
Sub-area 6C	7.03E-08	**4.1**	8.36E-08	0.060
Sub-area 6D	2.99E-10	0.00014	8.25E-08	0.013
Sub-area 8A	2.37E-08	0.00031	1.02E-07	0.020
Sub-area 8B	NA	**55**	3.74E-10	0.49
Sub-area 8C	NA	0.064	1.25E-12	0.0052
Area 9	1.79E-11	0.19	1.29E-11	0.008

Notes:

Number in bold exceeds the cumulative acceptable target levels.

IELCR: Individual excess lifetime cancer risk

HI: Hazard index

NA: Not available

N/A: Not applicable

Area 7 - No risk calculation was performed since there is only one sample location and no industrial activities.

* Risks calculated as per RAM (2004) approved risk assessment.

Table 1-4
Summary of Interim Action Remedial Excavations in 2005
Boeing Tract 1, Hazelwood, Missouri

Sub-area	Dimension of Excavated Area	Mass of Soil Excavated (tons)	Samples Excavated/Reference Table		Available Piezometers / Wells
Sub-area 2B	20 ft x 20 ft x 10 ft depth	2073.15 105.1 hazardous waste	B51I1 TP-1 (SB-1) TP-2 (SB-3) SB-4 TP-5 (SB-11) MW-7S (SB-14) SB-18	Table 3B-5(a) Table 3B-5(c) Table 3B-7(a) Table 3B-7(b) Table 3B-7(c)	MW-5I MW-6S MW-10S MW-11D MW-11I MW-11S TP-6 MW-8I MW-8S MW-9S
Sub-area 3A	11.5 ft x 9.5 ft x 8 ft depth	88.23	B42N5	Table 4A-5(a) Table 4A-5(b) Table 4A-5(c) Table 4A-7(a) Table 4A-7(b) Table 4A-7(c)	B42N6 B41MW-18
Sub-area 3E	7 ft x 8 ft x 4 ft depth	8.12	B2E2	Table 4E-7(a) Table 4E-7(b) Table 4E-7(c)	B2E3 B2E5
Sub-area 6B	15 ft x 15 ft x 6 ft depth	56.35	RC2 RC9	Table 7B-7(a) Table 7B-7(b) Table 7B-7(c) Table 7B-7(d) Table 7B-7(e)	RC14 MW3 MW7 MW9S B27W3D B28MW3 B28MW4
Sub-area 8B	10 ft x 10 ft x 5 ft depth	23.02	B220N1	Table 9B-8(b)	B220N4 B220N6 MW4

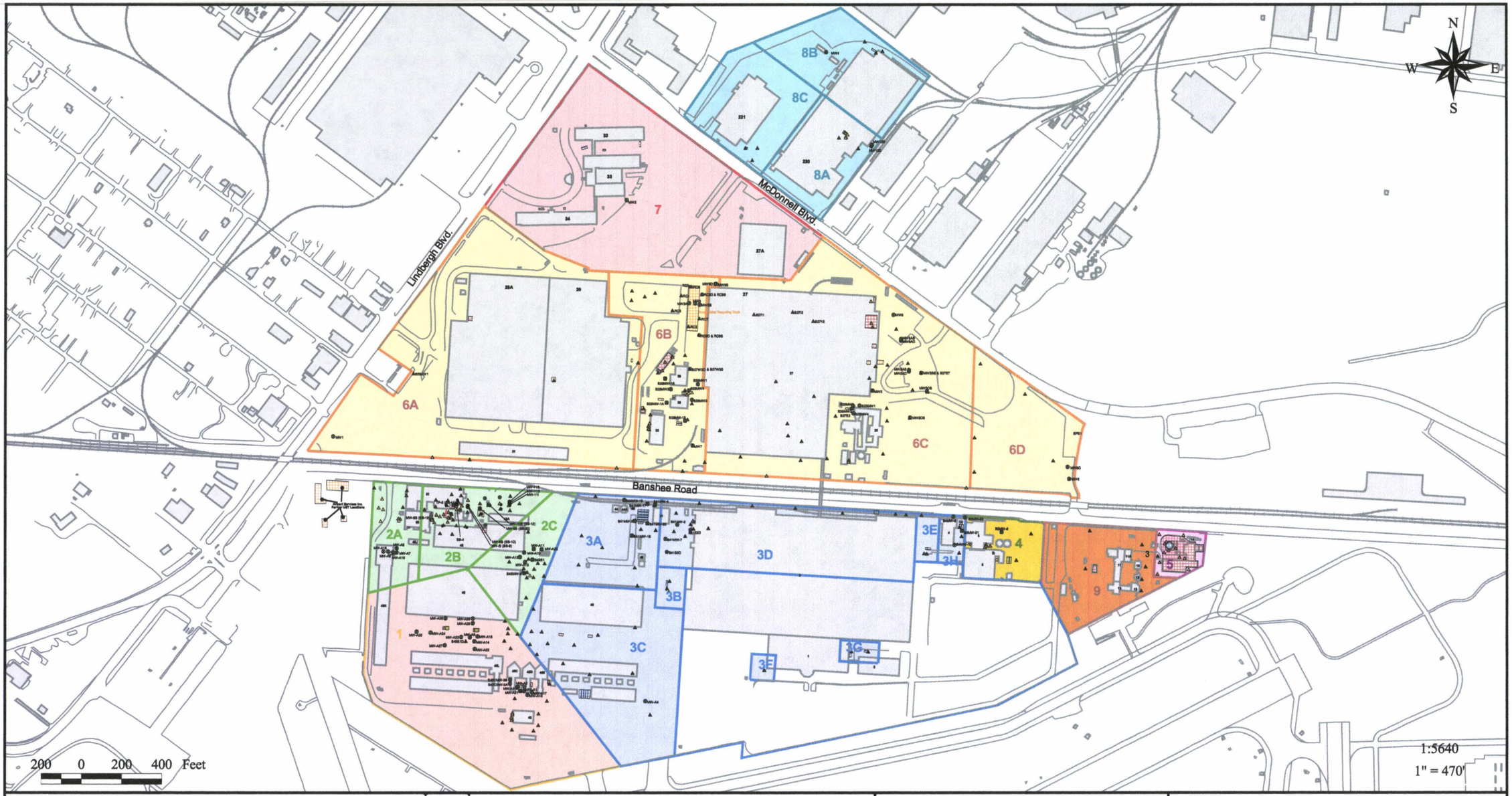
References:

Mactec, May 2006. Interim Action Remedial Excavation Completion Report, Boeing Tract 1, McDonnell Douglas, Hazelwood, Missouri.
Mactec, June 2006. Interim Measure Completion Report, Solid Waste Management Unit 17, McDonnell Douglas, Hazelwood, Missouri.

Table 2-1
Primary Chemicals and Routes of Exposure that Caused Risk and Hazard Exceedences
Combined RAM Group and Tetra Tech Risk Assessments
Boeing Tract 1, Hazelwood, Missouri

Area	COC	Media	Exceedence Due to	Risk Assessment
Sub-area 2A	TPH-GRO	GW	Indoor inhalation from groundwater by non-residential worker	RAM Group
	TPH-DRO	GW	Indoor inhalation from groundwater by non-residential worker	
Sub-area 2B	Aliphatics >nC12 to nC16	GW	Indoor inhalation from groundwater by non-residential worker	
	Aliphatics >nC16 to nC21	GW	Indoor inhalation from groundwater by non-residential worker	
	Aliphatics >nC21 to nC35	GW	Indoor inhalation from groundwater by non-residential worker	
	Tetrachloroethene	GW	Dermal contact with groundwater by future construction worker	
Sub-area 2C	Benzene	GW	Outdoor inhalation of vapors from groundwater by future construction worker	Tetra Tech
	TPH-GRO Aliphatics >nC5 to nC8	GW	Outdoor inhalation of vapors from groundwater by outdoor worker and future construction worker	
	TPH-GRO Aliphatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by outdoor worker and future construction worker	
	TPH-GRO Aromatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
Sub-area 3A	TPH-DRO	GW	Indoor inhalation from groundwater by non-residential worker	RAM Group
Sub-area 3C	TPH-DRO	GW	Indoor inhalation from groundwater by non-residential worker	
	TPH-ORO	GW	Indoor inhalation from groundwater by non-residential worker	
	Total TPH	GW	Outdoor inhalation of vapors from groundwater by construction worker	
Sub-area 3E	Aliphatics >nC16 to nC21	GW	Indoor inhalation from groundwater by non-residential worker	
Sub-area 3G	Aliphatics >nC21 to nC35	GW	Indoor inhalation from groundwater by non-residential worker	
Sub-area 3H	Mercury	GW	Outdoor inhalation of vapors from groundwater by future construction worker	Tetra Tech
	TPH-DRO Aliphatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	TPH-DRO Aromatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
Sub-area 6B	Aliphatics >nC16 to nC21	GW	Indoor inhalation from groundwater by non-residential worker	RAM Group
	Benzo(a)anthracene	GW	Dermal contact with groundwater by construction worker	
	1,2-dichloroethene (total)	GW	Outdoor inhalation of vapors from groundwater by future construction worker	Tetra Tech
	Benzene	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	Trichloroethene	GW	Outdoor inhalation of vapors from groundwater and dermal contact with groundwater by future construction worker	
	Vinyl chloride	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	Mercury	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	Aroclor 1254	GW	Dermal contact with groundwater by future construction worker	
	TPH-GRO Aliphatics >nC5 to nC8	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	TPH-GRO Aliphatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	TPH-GRO Aromatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
	TPH-DRO Aliphatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by outdoor worker and future construction worker	
	TPH-DRO Aromatics >nC9 to nC18	GW	Outdoor inhalation of vapors from groundwater by future construction worker	
Sub-area 6C	Aliphatics >nC16 to nC21	GW	Indoor inhalation from groundwater by non-residential worker	RAM Group
	Aliphatics >nC21 to nC35	GW	Indoor inhalation from groundwater by non-residential worker	
Sub-area 8B	Aliphatics >nC16 to nC21	GW	Indoor inhalation from groundwater by non-residential worker	
	Aliphatics >nC21 to nC35	GW	Indoor inhalation from groundwater by non-residential worker	

Notes:
TPH - total petroleum hydrocarbons
GRO - gasoline range organics
DRO - diesel range organics
ORO - oil range organics
C - carbon range
GW - groundwater



Legend

Abandoned Shallow Piezometer	RCRA Closure Shallow Boring	Other Area
Abandoned Shallow Well	RFI Deep Boring/Temp. Piezometer	UST
Deep Piezometer	RFI Shallow Boring	SWMU
Deep Well	RFI Shallow Boring/Temp. Piezometer	
Intermediate Well	Shallow Piezometer	
Other Shallow Boring	Shallow Well	
RFA Boring	UST Closure Sample	

Drawn by: BSM Approved by:

Checked by: Date: September 10, 2004

Risk Assessment & Management Group, Inc.

Figure 1-1
Risk Assessment Exposure Area Map, Boeing Tract 1 (North and South)

P:\1_Gis\3250035046\apr\risk\risk_fig1-1_040910.apr

N
W E
S

Legend

- Sampled Well
- Manhole
- Sewer Line
- Railroad
- Road
- Runway
- Building
- Parcel Boundary

0 95 190 380 Feet

1 inch = 14,400 feet

MW4
B220N4
B220N6
MW10D
MW10S
MW9S
RC14
RC8D
MW3
MW8AD
MW8AS
B27W3D
B28MW3
B28MW4
MW5CS
B25MW1
MW5DS
MW1
MW7
MW6D
MW6
MW-9S
TP-3
TP-6
SWMU17-0B-1
MW-5I
MW-11D
MW-11S
TP-4
MW-11I
MW-8I
MW-8S
MW-6S
MW-10S
B48N1
B41MW-18
B41MW-5
B41S5D
B4MW-9
B2E5
B4MW-10
B2E3
MW-A16
MW-A8
MW-A12
MW-A13
B42N6
MW-A26
MW-A29
MW-A15
MW-A25
MW-A27
MW-A22
MW-A23
MW-A3
MW-A1
MW-A4

J:\Boeing\Layouts\Existing_Well_Map_11x17.mxd

NO.	REVISIONS	DATE	BY	DESIGNED	GIS	SCALE	Gannett Fleming		Locations of Monitoring Wells	GF PROJECT NO.	SHEET NO.
	DESCRIPTION			DKB	CER	AS NOTED	BALTIMORE, MARYLAND	Report Wells		49992	2-1
				CHECKED	APPROVED					DATE 12-29-08	
										GIS FILE Existing_Well_Map_11x17.mxd	

APPENDIX A

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Jeremiah W. (Jay) Nixon, Governor • Mark N. Templeton, Director

www.dnr.mo.gov

August 24, 2009

CERTIFIED MAIL – 7004 1160 0000 8177 3797
RETURN RECEIPT REQUESTED

Mr. Joseph W. Haake
Group Manager
Environmental and Hazardous
Materials Services
The Boeing Company
Department 107E, Building 111
Mail Code S111-2491
P.O. Box 516
St. Louis, MO 63166-0516

RE: Risk-Based Corrective Action Report, Boeing Tract 1 Dated September 2004
Addendums to Risk-Based Corrective Action Report Dated June 29, 2009, and
Dated July 29, 2009, The Boeing Company, Hazelwood, Missouri
EPA ID# MOD000818963

Dear Mr. Haake:

This letter is to notify you that the Missouri Department of Natural Resources and the U.S. Environmental Protection Agency Region VII (EPA) reviewed The Boeing Company's Risk-Based Corrective Action Report, Boeing Tract 1, dated September 2004 and associated addendums dated June 29, 2009 and July 29, 2009. The Boeing Company submitted these documents as required by McDonnell Douglas' (a wholly owned subsidiary of The Boeing Company) Missouri Hazardous Waste Management Facility Part I Permit, Schedule of Compliance, Condition II, dated March 5, 1997. We are approving these documents based on our review.

Based on the results of the Resource Conservation and Recovery Act Facility Investigation Report approved on December 22, 2004, the Risk-Based Corrective Action Report, Boeing Tract 1, dated September 2004 and associated addendums dated June 29 and July 29, 2009, and the EPA's Final Risk Assessment, Boeing Tract 1 Facility, dated March 2008, the agencies' request

Boeing progress to the next phase of the Corrective Action process and prepare a Corrective Measures Study (CMS) Work Plan in accordance with Section VII., CMS Work Plan of the Missouri Hazardous Waste Management Facility Part I Permit.

The CMS Work Plan shall be consistent with guidance contained in the EPA document entitled: RCRA Corrective Action Plan (Final), May 1994, OSWER Directive 9902.3-2A. The CMS Work Plan shall outline the general approach to investigating and evaluating potential remedies at the facility, including a description of all remedies that will be studied and a detailed description of any proposed pilot, laboratory, and/or bench scale studies.

Please submit the CMS Work Plan within 60 days of your receipt of this approval letter. Please submit three copies addressed to the Permits Section Chief, Hazardous Waste Program and two copies to Ms. Stephanie Doolan, at U.S. EPA Region VII at 901 North Fifth Street, Kansas City, KS 66101.

If you have any questions regarding this letter, please contact Christine Kump-Mitchell, P.E., of my staff, at the Missouri Department of Natural Resources, 7545 South Lindbergh, Suite 210, St. Louis, MO 63125-4839, or by phone at (314) 416-2960 or 1-800-361-4827, or by e-mail at christine.kump@dnr.mo.gov. Thank you.

Sincerely,

HAZARDOUS WASTE PROGRAM

Richard A. Nussbaum, P.E., R.G.
Chief, Permits Section

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APPENDIX B

Table B-1
Comparison of 2004 RA Representative Concentrations with Revised Representative Concentrations after Interim Action
Boeing Tract 1, St. Louis, Missouri

COCs	Representative Concentration (ug/kg)																	
	SWMU-17						Sub-area 3A NR			Sub-area 3A CW			Sub-area 3E NR			Sub-area 3E CW		
	Sub-area 2B NR			Sub-area 2B CW														
	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio
Organics																		
1,1-Dichloroethane	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1,1-Dichloroethene	---	---	---	21	60	2.8	---	---	---	---	---	---	---	---	---	---	---	---
1,1,2-Trichloro-1,2,2-trifluoroethane	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	23	78	3.3	27	26	1.0	11	13	1.2	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	97	73	0.8	31	26	0.8	---	---	---	---	---	---
Acetone	2,122	3,885	1.8	1,034	1,966	1.9	---	---	---	---	---	---	57	68	1.2	57	68	1.2
Benzene	---	---	---	---	---	---	10	15	1.5	37	32	0.9	704	202	0.3	704	202	0.3
Bromomethane	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chloroethane	31	36	1.2	21	28	1.4	---	---	---	---	---	---	---	---	---	---	---	---
cis-1,2-Dichloroethene	171	283	1.7	3,706	3,128	0.8	---	---	---	---	---	---	---	---	---	---	---	---
Dichlorodifluoromethane	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	53	50	0.9	136	109	0.8	7	13	1.9	10	11	1.1	185	725	3.9	185	725	3.9
Isopropyl benzene	99	1,141	11.5	42	561	13.3	16	19	1.2	19	49	2.7	28	140	5.0	28	140	5.0
m,p-Xylene	---	---	---	182	199	1.1	15	15	1.0	11	11	1.0	---	---	---	---	---	---
Methyl ethyl ketone (MEK)	1,386	1,638	1.2	994	1,131	1.1	---	---	---	---	---	---	---	---	---	---	---	---
Methylene chloride	85	505	6.0	59	275	4.7	4	44	11.2	8	48	6.4	33	10	0.3	33	10	0.3
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---	---	---	---	134	39	0.3	134	39	0.3
Naphthalene	436	11,032	25.3	154	5,349	34.7	---	---	---	---	---	---	20	206	10.3	20	206	10.3
n-Butylbenzene	394	2,168	5.5	200	1,089	5.4	---	---	---	---	---	---	72	131	1.8	72	131	1.8
n-Propylbenzene	169	1,811	10.7	66	884	13.4	---	---	---	19	69	3.6	115	453	3.9	115	453	3.9
o-Xylene	---	---	---	65	70	1.1	---	---	---	---	---	---	---	---	---	---	---	---
p-Isopropyltoluene	93	442	4.7	48	266	5.6	59	63	1.1	21	42	2.0	---	---	---	---	---	---
sec-Butylbenzene	179	2,093	11.7	113	1,044	9.2	---	---	---	26	129	4.9	32	52	1.7	32	52	1.7
Tetrachloroethene	117,893	16,500	0.1	284,245	200,066	0.7	---	---	---	---	---	---	---	---	---	---	---	---
Toluene	85	505	5.9	177	352	2.0	15	51	3.5	8	50	6.1	377	115	0.3	377	112	0.3
trans-1,2-Dichlorobenzene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethene	20	82	4.2	470	420	0.9	---	---	---	---	---	---	---	---	---	---	---	---
Trichloroethene	244	128	0.5	688	498	0.7	---	---	---	---	---	---	---	---	---	---	---	---
Vinyl chloride	29	245	8.5	39	138	3.5	---	---	---	---	---	---	---	---	---	---	---	---
Xylenes, Total	137	352	2.6	507	518	1.02	7	41	6.1	20	40	2.0	362	1,533	4.2	362	1,533	4.2
Aroclor 1254	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acenaphthylene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(a)anthracene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzo(b)fluoranthene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Chrysene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluoranthene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Phenanthrene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pyrene	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TPHs																		
TPH-GRO	58,214	58,214	1.0	37,150	37,150	1.0	---	520,000	---	6,770	314,642	46.5	274,550	180,057	0.7	274,550	180,057	0.7
TPH-DRO	817,829	817,829	1.0	521,665	521,665	1.0	24,000	15,250	0.6	12,003	9,714	0.8	2,312	5,304	2.3	2,312	5,304	2.3
TPH-ORO	40,250	40,250	1.0	30,667	30,667	1.0	2,500	4,500	1.8	2,714	5,286	1.9	2,844	5,455	1.9	2,844	5,455	1.9

Table B-1
Comparison of 2004 RA Representative Concentrations with Revised Representative Concentrations after Interim Action
Boeing Tract 1, St. Louis, Missouri

COCs	Representative Concentration (ug/kg)																	
	SWMU-17						Sub-area 3A NR			Sub-area 3A CW			Sub-area 3E NR			Sub-area 3E CW		
	Sub-area 2B NR			Sub-area 2B CW														
	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio
Metals																		
Arsenic	11,546	11,546	1.0	10,969	10,969	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Barium	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium	1,638	1,638	1.0	1,289	1,289	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Chromium	25,878	25,878	1.0	22,860	22,860	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Mercury	114	114	1.0	194	194	1.0	---	---	---	94	94	1.0	---	---	---	---	---	---
Selenium	1,003	1,003	1.0	909	909	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Silver	1,289	1,289	1.0	1,122	1,122	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Antimony	2,513	2,513	1.0	2,513	2,513	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Beryllium	849	849	1.0	849	849	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Cobalt	6,613	6,613	1.0	6,613	6,613	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Copper	11,748	11,748	1.0	11,748	11,748	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Manganese	844,250	844,250	1.0	844,250	844,250	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Nickel	17,715	17,715	1.0	17,715	17,715	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Thallium	2,039	2,039	1.0	2,039	2,039	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Zinc	36,425	36,425	1.0	36,425	36,425	1.0	---	---	---	---	---	---	---	---	---	---	---	---
Minimum Ratio			0.14			0.70			0.64			0.81			0.29			0.29
Maximum Ratio			25.33			34.66			11.22			46.48			10.30			10.30
No. of COCs			35			39			12			16			15			15
No. of Ratio > 1			15			17			8			11			10			10

Notes:
CW: Construction worker
NR: Non-residential worker
ug/kg: Micrograms per kilogram
TPH-GRO: Total petroleum hydrocarbon-gasoline range organics
TPH-DRO: Total petroleum hydrocarbon-diesel range organics
TPH-oRO: Total petroleum hydrocarbon-oil range organics
2004 RA: Risk-Based Corrective Action Report (RAM Group, September 2004)
---: Not a chemical of concern
Ratio > 1 indicates that concentration after interim action increased

Table B-1
Comparison of 2004 RA Representative Concentrations with Revised Representative Concentrations after Interim Action
Boeing Tract 1, St. Louis, Missouri

COCs	Representative Concentration (ug/kg)								
	Sub-area 6B NR			Sub-area 6B CW			Sub-area 8B CW		
	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio
Organics									
1,1-Dichloroethane	---	---	---	3	3	1.0	---	---	---
1,1-Dichloroethene	---	---	---	4	3	0.8	---	---	---
1,1,2-Trichloro-1,2,2-trifluoroethane	---	---	---	---	---	---	---	---	---
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	---	---
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	---	---
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---	---
Acetone	79	67	0.8	31	30	1.0	---	---	---
Benzene	---	---	---	---	---	---	---	---	---
Bromomethane	---	---	---	---	---	---	---	---	---
Chloroethane	---	---	---	---	---	---	---	---	---
cis-1,2-Dichloroethene	75	1	0.01	146	87	0.6	---	---	---
Dichlorodifluoromethane	---	---	---	---	---	---	---	---	---
Ethylbenzene	5	3	0.7	123	63	0.5	---	---	---
Isopropyl benzene	---	---	---	---	---	---	---	---	---
m,p-Xylene	---	---	---	---	---	---	10	11	1.1
Methyl ethyl ketone (MEK)	---	---	---	14	12	0.8	---	---	---
Methylene chloride	---	---	---	7	6	0.8	---	---	---
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	---	---
Naphthalene	---	---	---	---	---	---	---	---	---
n-Butylbenzene	---	---	---	---	---	---	---	---	---
n-Propylbenzene	---	---	---	---	---	---	---	---	---
o-Xylene	---	---	---	---	---	---	---	---	---
p-Isopropyltoluene	---	---	---	---	---	---	---	---	---
sec-Butylbenzene	---	---	---	---	---	---	---	---	---
Tetrachloroethene	12	8	0.7	8	5	0.7	---	---	---
Toluene	13	9	0.7	4,893	2,448	0.5	---	---	---
trans-1,2-Dichlorobenzene	36	36	1.0	36	9	0.2	---	---	---
trans-1,2-Dichloroethene	---	---	---	22	36	1.6	---	---	---
Trichloroethene	27	15	0.6	42	21	0.5	---	---	---
Vinyl chloride	7	10	1.5	52	27	0.5	---	---	---
Xylenes, Total	14	10	0.7	382	202	0.5	---	---	---
Aroclor 1254	---	---	---	100	100	1.0	---	---	---
Acenaphthene	3,411	1,096	0.3	1,150	721	0.6	---	---	---
Acenaphthylene	48	40	0.8	29	29	1.0	---	---	---
Benzo(a)anthracene	27	126	4.7	17	103	6.0	---	---	---
Benzo(b)fluoranthene	27	126	4.7	14	102	7.3	66	66	1.0
Chrysene	193	173	0.9	119	159	1.3	44	44	1.0
Fluoranthene	217	185	0.9	102	146	1.4	---	---	---
Fluorene	42	133	3.2	27	109	4.0	---	---	---
Phenanthrene	---	---	---	17	17	1.0	---	---	---
Pyrene	180	171	1.0	86	136	1.6	---	---	---
TPHs									
TPH-GRO	810	478	0.6	3,103	1,835	0.6	---	---	---
TPH-DRO	17,500	47,583	2.7	177,083	137,545	0.8	---	---	---
TPH-ORO	---	129,750	---	---	1,835	---	---	---	---

Table B-1
Comparison of 2004 RA Representative Concentrations with Revised Representative Concentrations after Interim Action
Boeing Tract 1, St. Louis, Missouri

COCs	Representative Concentration (ug/kg)								
	Sub-area 6B NR			Sub-area 6B CW			Sub-area 8B CW		
	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio	2004 RA	Revised After Interim Action	Ratio
Metals									
Arsenic	27,807	27,807	1.0	14,266	14,266	1.0	---	---	---
Barium	---	---	---	---	---	---	---	---	---
Cadmium	583	583	1.0	481	481	1.0	---	---	---
Chromium	---	---	---	---	---	---	---	---	---
Mercury	34	34	1.0	42	42	1.0	---	---	---
Selenium	1,687	1,687	1.0	920	920	1.0	---	---	---
Silver	---	---	---	---	---	---	---	---	---
Antimony	3,964	3,964	1.0	3,964	3,964	1.0	---	---	---
Beryllium	937	937	1.0	937	937	1.0	---	---	---
Cobalt	8,404	8,404	1.0	8,404	8,404	1.0	---	---	---
Copper	19,350	19,350	1.0	19,350	19,350	1.0	---	---	---
Manganese	1,084,100	1,084,100	1.0	1,084,100	1,084,100	1.0	---	---	---
Nickel	28,150	28,150	1.0	28,150	28,150	1.0	---	---	---
Thallium	---	---	---	---	---	---	---	---	---
Zinc	52,140	52,140	1.0	52,140	52,140	1.0	---	---	---
Minimum Ratio			0.01			0.25			1.00
Maximum Ratio			4.73			7.30			1.13
No. of COCs			30			37			3
No. of Ratio > 1			5			7			1

Notes:
CW: Construction worker
NR: Non-residential worker
ug/kg: Micrograms per kilogram
TPH-GRO: Total petroleum hydrocarbon-gasoline range organics
TPH-DRO: Total petroleum hydrocarbon-diesel range organics
TPH-oRO: Total petroleum hydrocarbon-oil range organics
2004 RA: Risk-Based Corrective Action Report (RAM Group, September 2004)
---: Not a chemical of concern
Ratio > 1 indicates that concentration after interim action increased

Table 3B-12(a)

Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Current On-site Non-residential Worker
Sub-area 2B: Demolished Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Indoor Inhalation of Vapors from Subsurface Soil		Average GW Conc.	Indoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	(ug/L)	IELCR	HQ		
1,1-Dichloroethene	---	---	---	150	5.95E-07	5.95E-02	5.95E-07	5.95E-02
1,2,3-Trimethylbenzene	---	---	---	48	NA	1.91E-04	NA	1.91E-04
1,2,4-Trimethylbenzene	---	---	---	182	NA	1.41E-03	NA	1.41E-03
Acetone	3,885	NA	4.39E-05	---	---	---	NA	4.39E-05
Benzene	---	---	---	239	3.54E-08	3.54E-03	3.54E-08	3.54E-03
Chloroethane	36	1.54E-09	5.13E-07	---	---	---	1.54E-09	5.13E-07
cis-1,2-Dichloroethene	283	NA	1.64E-04	4,497	NA	4.26E-03	NA	4.42E-03
Ethylbenzene	50	NA	2.13E-07	---	---	---	NA	2.13E-07
Isopropyl benzene	1,141	NA	1.11E-04	---	---	---	NA	1.11E-04
Methyl ethyl ketone (MEK)	1,638	NA	3.57E-06	---	---	---	NA	3.57E-06
Methylene chloride	505	3.13E-09	6.20E-06	---	---	---	3.13E-09	6.20E-06
Methyl tert-butyl ether (MTBE)	---	---	---	222	4.76E-11	4.76E-06	4.76E-11	4.76E-06
Naphthalene	11,032	NA	1.48E-04	321	NA	3.95E-04	NA	5.43E-04
n-Butylbenzene	2,168	NA	1.46E-05	221	NA	1.48E-04	NA	1.63E-04
n-Propylbenzene	1,811	NA	3.66E-05	189	NA	1.03E-04	NA	1.39E-04
p-Isopropyltoluene	442	NA	1.12E-06	---	---	---	NA	1.12E-06
sec-Butylbenzene	2,093	NA	2.56E-05	207	NA	1.94E-04	NA	2.20E-04
Tetrachloroethene	16,500	7.54E-08	9.10E-04	19,115	4.91E-07	4.91E-02	5.67E-07	5.01E-02
Toluene	505	NA	1.05E-05	649	NA	9.32E-05	NA	1.04E-04
trans-1,2-Dichloroethene	82	NA	3.59E-05	150	NA	1.43E-04	NA	1.79E-04
Trichloroethene	128	9.93E-10	4.67E-05	1,991	9.58E-08	9.58E-03	9.68E-08	9.62E-03
Vinyl chloride	245	2.22E-06	7.27E-04	728	5.55E-06	5.55E-01	7.77E-06	5.56E-01
Xylenes, Total	352	NA	1.68E-06	---	---	---	NA	1.68E-06
Organics Total Risk		**2.30E-06**	**2.29E-03**		**6.77E-06**	**6.84E-01**	**9.07E-06**	**6.86E-01**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	4,660	NA	2.72E-03	NA	2.72E-03
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	2,732	NA	4.70E-02	NA	4.70E-02
Aromatics > nC8 to nC10 (TX1006)	---	---	---	2,732	NA	1.53E-03	NA	1.53E-03
TPH-GRO	**58,214**	**NA**	**5.96E-04**	**10,123**	**NA**	**5.12E-02**	**NA**	**5.18E-02**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	17,717	NA	4.57E-01	NA	4.57E-01
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	63,149	NA	7.05E+00	NA	7.05E+00
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	74,726	NA	7.86E+01	NA	7.86E+01
Aromatics > nC10 to nC12 (TX1006)	---	---	---	8,107	NA	1.47E-03	NA	1.47E-03
Aromatics > nC12 to nC16 (TX1006)	---	---	---	30,484	NA	2.30E-03	NA	2.30E-03
Aromatics > nC16 to nC21 (TX1006)	---	---	---	25,786	NA	5.42E-04	NA	5.42E-04
TPH-DRO	**817,829**	**NA**	**8.26E-04**	**219,968**	**NA**	**8.62E+01**	**NA**	**8.62E+01**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	8,786	NA	9.25E+00	NA	9.25E+00
Aromatics > nC21 to nC35 (TX1006)	---	---	---	7,028	NA	1.71E-05	NA	1.71E-05
TPH-ORO	**40,250**	**NA**	**1.03E-06**	**15,814**	**NA**	**9.25E+00**	**NA**	**9.25E+00**
TPH Total Risk		**NA**	**1.42E-03**		**NA**	**9.54E+01**	**NA**	**9.54E+01**
Arsenic	11,546	NA	NA	67	NA	NA	NA	NA
Cadmium	1,638	NA	NA	4.0	NA	NA	NA	NA
Chromium	25,878	NA	NA	---	---	---	NA	NA
Mercury	114	NA	3.22E-04	---	---	---	NA	3.22E-04
Selenium	1,003	NA	NA	---	---	---	NA	NA
Silver	1,289	NA	NA	---	---	---	NA	NA
Antimony	2,513	NA	NA	---	---	---	NA	NA
Beryllium	849	NA	NA	---	---	---	NA	NA
Cobalt	6,613	NA	NA	---	---	---	NA	NA
Copper	11,748	NA	NA	---	---	---	NA	NA
Manganese	844,250	NA	NA	---	---	---	NA	NA
Nickel	17,715	NA	NA	---	---	---	NA	NA
Thallium	2,039	NA	NA	---	---	---	NA	NA
Zinc	36,425	NA	NA	---	---	---	NA	NA
Metals Total Risk		**NA**	**3.22E-04**		**NA**	**NA**	**NA**	**3.22E-04**
CUMULATIVE RISK		**2.30E-06**	**4.03E-03**		**6.77E-06**	**9.61E+01**	**9.07E-06**	**9.61E+01**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter
GRO: Gasoline range organic
DRO: Diesel range organic
ORO: Oil range organic
TPH: Total petroleum hydrocarbon

Table 3B-12(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 2B: Demolished Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc.	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ	(ug/L)	IELCR	HQ	IELCR	HQ		
1,1-Dichloroethene	60	1.79E-10	2.32E-06	1.99E-10	2.58E-06	6.48E-10	4.55E-06	150	2.28E-07	2.95E-03	2.34E-10	1.64E-06	2.29E-07	2.96E-03
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	48	NA	NA	NA	3.11E-06	NA	3.11E-06
1,2,4-Trimethylbenzene	78	NA	5.44E-07	NA	5.56E-07	NA	1.15E-05	182	NA	NA	NA	1.73E-05	NA	3.00E-05
Acetone	1,966	NA	6.86E-06	NA	7.24E-06	NA	1.70E-05	---	---	---	---	---	NA	3.11E-05
Benzene	---	---	---	---	---	---	---	239	4.61E-08	3.71E-02	1.89E-11	2.68E-05	4.61E-08	3.71E-02
Chloroethane	28	1.35E-12	8.14E-08	4.49E-13	2.71E-08	6.08E-12	5.06E-08	---	---	---	---	---	7.87E-12	1.59E-07
cis-1,2-Dichloroethene	3,128	NA	1.09E-05	NA	1.21E-04	NA	6.14E-04	4,497	NA	NA	NA	7.15E-05	NA	8.18E-04
Ethylbenzene	109	NA	3.80E-07	NA	3.89E-07	NA	3.40E-07	---	---	---	---	---	NA	1.11E-06
Isopropyl benzene	561	NA	1.96E-06	NA	2.17E-06	NA	1.36E-05	---	---	---	---	---	NA	1.77E-05
m,p-Xylene	199	NA	1.16E-07	NA	3.86E-08	NA	1.88E-06	---	---	---	---	---	NA	2.03E-06
Methyl ethyl ketone (MEK)	1,131	NA	6.57E-07	NA	7.30E-07	NA	2.55E-06	---	---	---	---	---	NA	3.93E-06
Methylene chloride	275	1.03E-11	1.60E-06	1.14E-11	1.78E-06	1.71E-11	8.48E-07	---	---	---	---	---	3.88E-11	4.22E-06
Methyl tert-butyl ether	---	---	---	---	---	---	---	222	1.04E-09	2.58E-05	1.03E-13	2.39E-08	1.04E-09	2.58E-05
Naphthalene	5,349	NA	9.33E-05	NA	1.04E-04	NA	5.44E-04	321	NA	NA	NA	2.52E-05	NA	7.66E-04
n-Butylbenzene	1,089	NA	3.16E-05	NA	1.05E-05	NA	1.15E-05	221	NA	NA	NA	1.58E-06	NA	5.53E-05
n-Propylbenzene	884	NA	3.08E-04	NA	3.43E-04	NA	1.62E-05	189	NA	NA	NA	1.14E-06	NA	6.68E-04
o-Xylene	70	NA	4.07E-08	NA	1.36E-08	NA	6.85E-08	---	---	---	---	---	NA	1.23E-07
p-Isopropyltoluene	266	NA	3.09E-06	NA	1.03E-06	NA	1.18E-06	---	---	---	---	---	NA	5.30E-06
sec-Butylbenzene	1,044	NA	3.03E-05	NA	1.01E-05	NA	1.49E-05	207	NA	NA	NA	1.97E-06	NA	5.73E-05
Tetrachloroethene	200,066	5.18E-09	6.98E-04	5.76E-08	7.75E-03	1.19E-08	3.58E-03	19,115	1.51E-05	2.03E+00	2.02E-10	6.09E-05	1.52E-05	2.04E+00
Toluene	352	NA	6.14E-08	NA	6.82E-07	NA	3.87E-06	649	NA	3.24E-03	NA	1.14E-06	NA	3.24E-03
trans-1,2-Dichloroethene	420	NA	7.32E-07	NA	8.14E-06	NA	5.06E-05	150	NA	NA	NA	1.85E-06	NA	6.14E-05
Trichloroethene	498	4.55E-14	4.82E-08	3.03E-11	3.22E-05	6.59E-11	7.75E-05	1,991	1.11E-07	1.18E-01	4.36E-11	5.12E-05	1.11E-07	1.18E-01
Vinyl chloride	138	1.31E-12	1.60E-08	1.45E-09	1.78E-05	4.39E-09	3.60E-05	728	3.19E-06	3.92E-02	2.00E-09	1.63E-05	3.20E-06	3.93E-02
Xylenes, Total	518	NA	3.01E-09	NA	2.51E-08	NA	2.06E-06	---	---	---	---	---	NA	2.09E-06
Organics Total Risk		**5.38E-09**	**1.19E-03**	**5.93E-08**	**8.42E-03**	**1.70E-08**	**5.01E-03**		**1.87E-05**	**2.23E+00**	**2.49E-09**	**2.82E-04**	**1.88E-05**	**2.25E+00**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	---	---	---	---	4,660	NA	NA	NA	2.43E-05	NA	2.43E-05
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	2,732	NA	NA	NA	4.18E-04	NA	4.18E-04
Aromatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	2,732	NA	NA	NA	1.65E-05	NA	1.65E-05
TPH-GRO	**37,150**	**NA**	**NA**	**NA**	**1.69E-04**	**NA**	**2.19E-04**	**10,123**	**NA**	**NA**	**NA**	**4.59E-04**	**NA**	**8.47E-04**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	17,717	NA	NA	NA	4.07E-03	NA	4.07E-03
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	63,149	NA	NA	NA	6.28E-02	NA	6.28E-02
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	74,726	NA	NA	NA	7.00E-01	NA	7.00E-01
Aromatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	8,107	NA	NA	NA	2.26E-05	NA	2.26E-05
Aromatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	30,484	NA	NA	NA	5.93E-05	NA	5.93E-05
Aromatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	25,786	NA	NA	NA	4.01E-05	NA	4.01E-05
TPH-DRO	**521,665**	**NA**	**1.15E-03**	**NA**	**3.50E-03**	**NA**	**1.00E-03**	**219,968**	**NA**	**NA**	**NA**	**7.66E-01**	**NA**	**7.72E-01**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	8,786	NA	NA	NA	8.22E-02	NA	8.22E-02
Aromatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	7,028	NA	NA	NA	9.46E-06	NA	9.46E-06
TPH-ORO	**30,667**	**NA**	**7.81E-05**	**NA**	**2.01E-04**	**NA**	**6.33E-06**	**15,814**	**NA**	**NA**	**NA**	**8.23E-02**	**NA**	**8.25E-02**
TPH Total Risk		**NA**	**1.23E-03**	**NA**	**3.87E-03**	**NA**	**1.23E-03**		**NA**	**NA**	**NA**	**8.49E-01**	**NA**	**8.56E-01**

Table 3B-12(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 2B: Demolished Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc.	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ	(ug/L)	IELCR	HQ	IELCR	HQ		
Arsenic	10,969	2.73E-10	4.25E-05	8.65E-08	1.35E-02	1.44E-10	2.24E-06	67	NA	NA	NA	NA	8.69E-08	1.35E-02
Cadmium	1,289	NA	3.00E-05	NA	9.99E-04	7.11E-12	1.58E-07	4.0	NA	NA	NA	NA	7.11E-12	1.03E-03
Chromium	22,860	NA	NA	NA	NA	8.40E-10	NA	---	---	---	---	---	8.40E-10	NA
Mercury	194	NA	7.54E-07	NA	3.77E-05	NA	9.09E-04	---	---	---	---	---	NA	9.47E-04
Selenium	909	NA	2.11E-05	NA	7.04E-05	NA	9.77E-07	---	---	---	---	---	NA	9.26E-05
Silver	1,122	NA	7.83E-05	NA	8.69E-05	NA	2.40E-05	---	---	---	---	---	NA	1.89E-04
Antimony	2,513	NA	7.30E-05	NA	2.43E-03	NA	2.70E-06	---	---	---	---	---	NA	2.51E-03
Beryllium	849	6.06E-10	4.93E-06	2.02E-10	1.64E-06	6.24E-12	9.10E-09	---	---	---	---	---	8.14E-10	6.59E-06
Cobalt	6,613	NA	3.84E-04	NA	1.28E-04	5.67E-11	7.11E-05	---	---	---	---	---	5.67E-11	5.83E-04
Copper	11,748	NA	3.41E-06	NA	1.14E-04	NA	2.52E-06	---	---	---	---	---	NA	1.20E-04
Manganese	844,250	NA	2.10E-03	NA	2.34E-03	NA	3.69E-03	---	---	---	---	---	NA	8.13E-03
Nickel	17,715	NA	5.15E-07	NA	3.43E-05	1.30E-11	1.90E-05	---	---	---	---	---	1.30E-11	5.38E-05
Thallium	2,039	NA	2.96E-04	NA	9.87E-03	NA	1.56E-06	---	---	---	---	---	NA	1.02E-02
Zinc	36,425	NA	1.41E-06	NA	1.18E-05	NA	7.44E-09	---	---	---	---	---	NA	1.32E-05
Metals Total Risk		**8.79E-10**	**3.04E-03**	**8.67E-08**	**2.96E-02**	**1.07E-09**	**4.73E-03**		**NA**	**NA**	**NA**	**NA**	**8.87E-08**	**3.74E-02**
CUMULATIVE RISK		**6.25E-09**	**5.46E-03**	**1.46E-07**	**4.19E-02**	**1.81E-08**	**1.10E-02**		**1.87E-05**	**2.23E+00**	**2.49E-09**	**8.49E-01**	**1.88E-05**	**3.14E+00**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter
GRO: Gasoline range organic
DRO: Diesel range organic
ORO: Oil range organic
TPH: Total petroleum hydrocarbon

Table 4A-10(a)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Current On-site Non-residential Worker
Sub-area 3A: Retained Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Indoor Inhalation of Vapors from Subsurface Soil		Average GW Conc. (ug/L)	Indoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ		IELCR	HQ		
1,2,4-Trimethylbenzene	26	NA	1.47E-06	7.8	NA	6.86E-05	NA	7.01E-05
1,3,5-Trimethylbenzene	73	NA	2.62E-05	---	---	---	NA	2.62E-05
Benzene	15	9.13E-10	5.19E-05	69	1.15E-08	1.15E-03	1.25E-08	1.21E-03
cis-1,2-Dichloroethene	---	---	---	381	NA	3.97E-04	NA	3.97E-04
Ethylbenzene	12.7	NA	5.40E-08	---	---	---	NA	5.40E-08
Isopropylbenzene	19	NA	1.84E-06	---	---	---	NA	1.84E-06
m,p-Xylene	15	NA	2.42E-07	---	---	---	NA	2.42E-07
Methylene chloride	44.3	2.75E-10	5.45E-07	---	---	---	2.75E-10	5.45E-07
n-Propylbenzene	---	---	---	71	NA	4.47E-05	NA	4.47E-05
p-Isopropyltoluene	63	NA	1.60E-07	---	---	---	NA	1.60E-07
Toluene	51	NA	1.07E-06	---	---	---	NA	1.07E-06
Vinyl chloride	---	---	---	7.3	6.68E-08	6.68E-03	6.68E-08	6.68E-03
Xylenes, Total	40.9	NA	1.95E-07	---	---	---	NA	1.95E-07
Organics Total Risk		**1.19E-09**	**8.37E-05**		**7.84E-08**	**8.35E-03**	**7.96E-08**	**8.43E-03**
TPH-GRO	---	---	---	1,060	NA	7.83E-03	NA	7.83E-03
TPH-DRO	24,000	NA	1.54E-05	6,983	NA	1.68E+00	NA	1.68E+00
TPH-ORO	4,500	NA	1.15E-07	1,449	NA	9.23E-01	NA	9.23E-01
TPH Total Risk		**NA**	**1.56E-05**		**NA**	**2.61E+00**	**NA**	**2.61E+00**
Arsenic	---	---	---	100	NA	NA	NA	NA
Metals Total Risk		**NA**	**NA**		**NA**	**NA**	**NA**	**NA**
CUMULATIVE RISK		**1.19E-09**	**9.92E-05**		**7.84E-08**	**2.62E+00**	**7.96E-08**	**2.62E+00**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
DRO: Diesel range organic
GRO: Gasoline range organic
ORO: Oil range organic
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter

Table 4A-10(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 3A: Retained Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
1,2,4-Trimethylbenzene	13	NA	8.89E-08	NA	9.88E-08	NA	1.89E-06	7.8	NA	NA	NA	1.64E-06	NA	3.72E-06
1,3,5-Trimethylbenzene	26	NA	1.78E-07	NA	1.98E-07	NA	9.53E-06	---	---	---	---	---	NA	9.90E-06
Benzene	32	4.61E-12	3.71E-06	5.13E-12	4.13E-06	2.62E-11	3.72E-05	69	1.33E-08	1.07E-02	1.21E-11	1.72E-05	1.33E-08	1.08E-02
cis-1,2-Dichloroethene	---	---	---	---	---	---	---	381	NA	NA	NA	1.34E-05	NA	1.34E-05
Ethylbenzene	11	NA	3.89E-08	NA	3.97E-08	NA	3.48E-08	---	---	---	---	---	NA	1.13E-07
Isopropylbenzene	49	NA	1.72E-07	NA	1.91E-07	NA	1.20E-06	---	---	---	---	---	NA	1.56E-06
m,p-Xylene	11	NA	6.44E-09	NA	2.15E-09	NA	1.05E-07	---	---	---	---	---	NA	1.13E-07
Methylene chloride	48.4	1.81E-12	2.81E-07	2.01E-12	3.12E-07	3.01E-12	1.49E-07	---	---	---	---	---	6.83E-12	7.42E-07
n-Propylbenzene	69	NA	2.41E-05	NA	2.67E-05	NA	1.26E-06	71	NA	NA	NA	9.52E-07	NA	5.30E-05
p-Isopropyltoluene	42	NA	4.89E-07	NA	1.63E-07	NA	1.86E-07	---	---	---	---	---	NA	8.38E-07
sec-Butylbenzene	129	NA	3.75E-06	NA	1.25E-06	NA	1.84E-06	---	---	---	---	---	NA	6.85E-06
Toluene	49.8	NA	8.68E-09	NA	9.64E-08	NA	5.47E-07	---	---	---	---	---	NA	6.52E-07
Vinyl chloride	---	---	---	---	---	---	---	7.3	3.18E-08	3.91E-04	4.45E-11	3.64E-07	3.18E-08	3.91E-04
Xylenes, Total	40	NA	7.01E-09	NA	7.16E-09	NA	1.60E-07	---	---	---	---	---	NA	1.74E-07
Organics Total Risk		**6.42E-12**	**3.28E-05**	**7.13E-12**	**3.32E-05**	**2.92E-11**	**5.41E-05**		**4.51E-08**	**1.11E-02**	**5.66E-11**	**3.36E-05**	**4.52E-08**	**1.12E-02**
TPH-GRO	314,642	NA	NA	NA	1.43E-03	NA	1.85E-03	1,060	NA	NA	NA	1.30E-04	NA	3.41E-03
TPH-DRO	9,714	NA	2.14E-05	NA	6.51E-05	NA	1.86E-05	6,983	NA	NA	NA	2.76E-02	NA	2.77E-02
TPH-ORO	5,286	NA	1.35E-05	NA	3.46E-05	NA	1.09E-06	1,449	NA	NA	NA	1.52E-02	NA	1.52E-02
TPH Total Risk		**NA**	**3.49E-05**	**NA**	**1.53E-03**	**NA**	**1.87E-03**		**NA**	**NA**	**NA**	**4.28E-02**	**NA**	**4.63E-02**
Arsenic	---	---	---	---	---	---	---	100	NA	NA	NA	NA	NA	NA
Mercury	94	NA	3.64E-07	NA	1.82E-05	NA	4.39E-04	---	---	---	---	---	NA	4.58E-04
Metals Total Risk		**NA**	**3.64E-07**	**NA**	**1.82E-05**	**NA**	**4.39E-04**		**NA**	**NA**	**NA**	**NA**	**NA**	**4.58E-04**
CUMULATIVE RISK		**6.42E-12**	**6.81E-05**	**7.13E-12**	**1.58E-03**	**2.92E-11**	**2.37E-03**		**4.51E-08**	**1.11E-02**	**5.66E-11**	**4.29E-02**	**4.52E-08**	**5.80E-02**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
DRO: Diesel range organic
GRO: Gasoline range organic
ORO: Oil range organic
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter

Table 4E-10(a)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Current On-site Non-residential Worker
Sub-area 3E: Retained Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Indoor Inhalation of Vapors from Subsurface Soil		Average GW Conc. (ug/L)	Indoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ		IELCR	HQ		
1,2,4-Trimethylbenzene	---	---	---	2,500	NA	1.93E-02	NA	1.93E-02
Acetone	68	NA	7.66E-07	540	NA	1.43E-06	NA	2.19E-06
Benzene	202	1.23E-08	6.99E-04	---	---	---	1.23E-08	6.99E-04
Ethylbenzene	725	NA	3.07E-06	1,245	NA	7.12E-05	NA	7.42E-05
Isopropylbenzene	140	NA	1.36E-05	---	---	---	NA	1.36E-05
Methyl tert-butyl ether	39	1.17E-11	1.09E-07	---	---	---	1.17E-11	1.09E-07
Methylene chloride	10	6.19E-11	1.23E-07	---	---	---	6.19E-11	1.23E-07
m,p-Xylene	---	---	---	5,300	NA	6.41E-04	NA	6.41E-04
Naphthalene	206	NA	2.75E-06	930	NA	1.14E-03	NA	1.14E-03
n-Butylbenzene	131	NA	8.82E-07	---	---	---	NA	8.82E-07
n-Propylbenzene	453	NA	9.15E-06	380	NA	2.05E-04	NA	2.15E-04
sec-Butylbenzene	52	NA	6.35E-07	---	---	---	NA	6.35E-07
Toluene	115	NA	2.38E-06	---	---	---	NA	2.38E-06
Xylenes, total	1533	NA	7.30E-06	---	---	---	NA	7.30E-06
Organics Total Risk		**1.24E-08**	**7.40E-04**		**NA**	**2.14E-02**	**1.24E-08**	**2.21E-02**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	4,917	NA	2.87E-03	NA	2.87E-03
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	4,917	NA	8.43E-02	NA	8.43E-02
Aromatics > nC8 to nC10 (TX1006)	---	---	---	19,667	NA	1.10E-02	NA	1.10E-02
TPH-GRO	**180,057**	**NA**	**1.84E-03**	**29,500**	**NA**	**9.82E-02**	**NA**	**1.00E-01**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	8,338	NA	2.14E-01	NA	2.14E-01
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	8,338	NA	9.29E-01	NA	9.29E-01
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	8,338	NA	8.75E+00	NA	8.75E+00
Aromatics > nC10 to nC12 (TX1006)	---	---	---	8,338	NA	1.51E-03	NA	1.51E-03
Aromatics > nC12 to nC16 (TX1006)	---	---	---	8,338	NA	6.28E-04	NA	6.28E-04
Aromatics > nC16 to nC21 (TX1006)	---	---	---	8,338	NA	1.75E-04	NA	1.75E-04
TPH-DRO	**5,304**	**NA**	**5.35E-06**	**50,025**	**NA**	**9.90E+00**	**NA**	**9.90E+00**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	373	NA	3.92E-01	NA	3.92E-01
Aromatics > nC21 to nC35 (TX1006)	---	---	---	4,477	NA	1.09E-05	NA	1.09E-05
TPH-ORO	**5,455**	**NA**	**1.39E-07**	**4,850**	**NA**	**3.92E-01**	**NA**	**3.92E-01**
TPH Total Risk		**NA**	**1.84E-03**		**NA**	**1.04E+01**	**NA**	**1.04E+01**
CUMULATIVE RISK		**1.24E-08**	**2.58E-03**		**NA**	**1.04E+01**	**1.24E-08**	**1.04E+01**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
DRO: Diesel range organic
GRO: Gasoline range organic
ORO: Oil range organic
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter

Table 4E-10(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 3E: Retained Area, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	2,500	NA	NA	NA	2.35E-04	NA	2.35E-04
Acetone	68	NA	2.37E-07	NA	2.50E-07	NA	5.89E-07	540	NA	NA	NA	3.43E-07	NA	1.42E-06
Benzene	202	2.92E-11	2.35E-05	3.24E-11	2.61E-05	1.66E-10	2.35E-04	---	---	---	---	---	2.27E-10	2.85E-04
Ethylbenzene	725	NA	2.53E-06	NA	2.58E-06	NA	2.26E-06	1,245	NA	2.04E-02	NA	8.34E-07	NA	2.04E-02
Isopropylbenzene	140	NA	4.88E-07	NA	5.42E-07	NA	3.39E-06	---	---	---	---	---	NA	4.42E-06
Methylene chloride	39	3.58E-13	5.57E-08	3.98E-13	6.19E-08	5.97E-13	2.95E-08	---	---	---	---	---	1.35E-12	1.47E-07
Methyl tert-butyl ether	10	6.69E-13	1.65E-08	7.44E-13	1.83E-08	2.57E-13	5.99E-08	---	---	---	---	---	1.67E-12	9.47E-08
m,p-Xylene	---	---	---	---	---	---	---	5,300	NA	4.69E-03	NA	7.76E-06	NA	4.70E-03
Naphthalene	206	NA	3.59E-06	NA	3.99E-06	NA	2.09E-05	930	NA	NA	NA	6.79E-05	NA	9.64E-05
n-Butylbenzene	131	NA	3.81E-06	NA	1.27E-06	NA	1.39E-06	---	---	---	---	---	NA	6.46E-06
n-Propylbenzene	453	NA	1.58E-04	NA	1.76E-04	NA	8.30E-06	380	NA	NA	NA	2.26E-06	NA	3.44E-04
sec-Butylbenzene	52	NA	1.51E-06	NA	5.04E-07	NA	7.41E-07	---	---	---	---	---	NA	2.76E-06
Toluene	115	NA	2.01E-08	NA	2.23E-07	NA	1.26E-06	---	---	---	---	---	NA	1.51E-06
Xylenes, Total	1,533	NA	2.67E-07	NA	2.73E-07	NA	6.10E-06	---	---	---	---	---	NA	6.64E-06
Organics Total Risk		**3.02E-11**	**1.94E-04**	**3.36E-11**	**2.11E-04**	**1.66E-10**	**2.80E-04**		**NA**	**2.51E-02**	**NA**	**3.14E-04**	**2.30E-10**	**2.61E-02**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	---	---	---	---	4,917	NA	NA	NA	2.54E-05	NA	2.54E-05
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	4,917	NA	NA	NA	7.47E-04	NA	7.47E-04
Aromatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	19,667	NA	NA	NA	1.18E-04	NA	1.18E-04
TPH-GRO	**180,057**	**NA**	**NA**	**NA**	**8.19E-04**	**NA**	**1.06E-03**	**29,500**	**NA**	**NA**	**NA**	**8.90E-04**	**NA**	**2.77E-03**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	1.90E-03	NA	1.90E-03
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	8.22E-03	NA	8.22E-03
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	7.75E-02	NA	7.75E-02
Aromatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	2.28E-05	NA	2.28E-05
Aromatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	1.58E-05	NA	1.58E-05
Aromatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	8,338	NA	NA	NA	1.19E-05	NA	1.19E-05
TPH-DRO	**5,304**	**NA**	**1.17E-05**	**NA**	**3.56E-05**	**NA**	**1.02E-05**	**50,025**	**NA**	**NA**	**NA**	**8.76E-02**	**NA**	**8.77E-02**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	373	NA	NA	NA	3.47E-03	NA	3.47E-03
Aromatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	4,477	NA	NA	NA	3.56E-06	NA	3.56E-06
TPH-ORO	**5,455**	**NA**	**1.39E-05**	**NA**	**3.58E-05**	**NA**	**1.13E-06**	**4,850**	**NA**	**NA**	**NA**	**3.47E-03**	**NA**	**3.52E-03**
TPH Total Risk		**NA**	**2.56E-05**	**NA**	**8.90E-04**	**NA**	**1.07E-03**		**NA**	**NA**	**NA**	**9.20E-02**	**NA**	**9.40E-02**
CUMULATIVE RISK		**3.02E-11**	**2.20E-04**	**3.36E-11**	**1.10E-03**	**1.66E-10**	**1.35E-03**		**NA**	**2.51E-02**	**NA**	**9.23E-02**	**2.30E-10**	**1.20E-01**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
DRO: Diesel range organic
GRO: Gasoline range organic
ORO: Oil range organic
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter

Table 7B-10(a)

Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Current On-site Non-residential Worker

Sub-area 6B: GKN Facility, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Indoor Inhalation of Vapors from Subsurface Soil		Average GW Conc. (ug/L)	Indoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ		IELCR	HQ		
1,1-Dichloroethene	---	---	---	8.0	3.64E-08	1.02E-05	3.64E-08	1.02E-05
1,1,2-Trichloro-1,2,2-trifluoroethane	---	---	---	640	NA	3.34E-05	NA	3.34E-05
1,2,3-Trimethylbenzene	---	---	---	0.7	NA	3.16E-06	NA	3.16E-06
1,2,4-Trimethylbenzene	---	---	---	3.4	NA	2.91E-05	NA	2.91E-05
Acetone	67	NA	7.52E-07	---	---	---	NA	7.52E-07
Benzene	---	---	---	13	2.18E-09	1.24E-04	2.18E-09	1.24E-04
Bromomethane	---	---	---	14	NA	1.54E-04	NA	1.54E-04
cis-1,2-Dichloroethene	1	NA	4.77.E-07	582	NA	5.97E-04	NA	5.98E-04
Dichlorodifluoromethane	---	---	---	35	NA	1.47E-04	NA	1.47E-04
Ethylbenzene	3.2	NA	1.36E-08	---	---	---	NA	1.36E-08
Methylene chloride	---	---	---	13	5.73E-11	1.13E-07	5.73E-11	1.13E-07
Methyl tert-butyl ether (MTBE)	---	---	---	32	6.91E-12	6.43E-08	6.91E-12	6.43E-08
Tetrachloroethene	8	3.50E-11	4.23E-07	20	5.75E-10	6.95E-06	6.11E-10	7.37E-06
Toluene	9	NA	1.93E-07	---	---	---	NA	1.93E-07
trans-1,2-Dichlorobenzene	36	NA	1.04E-07	---	---	---	NA	1.04E-07
trans-1,2-Dichloroethene	---	---	---	58	NA	6.17E-05	NA	6.17E-05
Trichloroethene	15	1.19E-10	5.59E-06	112	6.07E-09	2.85E-04	6.19E-09	2.91E-04
Vinyl chloride	10.3	9.35E-08	3.06E-05	149	1.33E-06	4.34E-04	1.42E-06	4.65E-04
Xylenes, total	10	NA	4.74E-08	---	---	---	NA	4.74E-08
Aroclor 1254	---	---	---	296	NA	NA	NA	NA
Acenaphthene	1,096	NA	1.62E-08	---	---	---	NA	1.62E-08
Acenaphthylene	40	NA	4.88E-10	---	---	---	NA	4.88E-10
Benzo(a)anthracene	126	1.34E-13	NA	126	2.56E-09	NA	2.56E-09	NA
Benzo(b)fluoranthene	126	7.60E-14	NA	---	---	---	7.60E-14	NA
Chrysene	173	3.21E-15	NA	---	---	---	3.21E-15	NA
Fluoranthene	185	NA	6.17E-11	---	---	---	NA	6.17E-11
Fluorene	133	NA	7.42E-10	---	---	---	NA	7.42E-10
Pyrene	171	NA	7.78E-11	---	---	---	NA	7.78E-11
Organics Total Risk		**9.36E-08**	**3.82E-05**		**1.37E-06**	**1.89E-03**	**1.47E-06**	**1.92E-03**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	885	NA	6.06E-04	NA	6.06E-04
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	55	NA	1.11E-03	NA	1.11E-03
Aromatics > nC8 to nC10 (TX1006)	---	---	---	55	NA	3.52E-05	NA	3.52E-05
TPH-GRO	**478**	**NA**	**4.90E-06**	**996**	**NA**	**1.75E-03**	**NA**	**1.76E-03**

Table 7B-10(a)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Current On-site Non-residential Worker
Sub-area 6B: GKN Facility, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Indoor Inhalation of Vapors from Subsurface Soil		Average GW Conc. (ug/L)	Indoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ		IELCR	HQ		
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	5,575	NA	1.68E-01	NA	1.68E-01
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	5,575	NA	7.29E-01	NA	7.29E-01
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	5,575	NA	6.87E+00	NA	6.87E+00
Aromatics > nC10 to nC12 (TX1006)	---	---	---	5,575	NA	1.10E-03	NA	1.10E-03
Aromatics > nC12 to nC16 (TX1006)	---	---	---	5,575	NA	4.43E-04	NA	4.43E-04
Aromatics > nC16 to nC21 (TX1006)	---			5,575	NA	1.19E-04	NA	1.19E-04
TPH-DRO	**47,583**	**NA**	**4.82E-05**	**33,451**	**NA**	**7.77E+00**	**NA**	**7.77E+00**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	75	NA	9.24E-02	NA	9.24E-02
Aromatics > nC21 to nC35 (TX1006)	---	---	---	75	NA	1.83E-07	NA	1.83E-07
TPH-ORO	**---**	**---**	**---**	**150**	**NA**	**9.24E-02**	**NA**	**9.24E-02**
TPH Total Risk		**NA**	**5.31E-05**		**NA**	**7.86E+00**	**NA**	**7.86E+00**
Arsenic	27,807	NA	NA	108	NA	NA	NA	NA
Barium	---	---	---	5,440	NA	NA	NA	NA
Cadmium	583	NA	NA	1,177	NA	NA	NA	NA
Chromium	---	---	---	412	NA	NA	NA	NA
Mercury	34	NA	9.69E-05	1.2	NA	1.53E-04	NA	2.50E-04
Selenium	1,687	NA	NA	---	---	---	NA	NA
Antimony	3,964	NA	NA	---	---	---	NA	NA
Beryllium	937	NA	NA	---	---	---	NA	NA
Cobalt	8,404	NA	NA	---	---	---	NA	NA
Copper	19,350	NA	NA	---	---	---	NA	NA
Manganese	1,084,100	NA	NA	6,400	NA	NA	NA	NA
Nickel	28,150	NA	NA	---	---	---	NA	NA
Zinc	52,140	NA	NA	---	---	---	NA	NA
Metals Total Risk		**NA**	**9.69E-05**		**NA**	**1.53E-04**	**NA**	**2.50E-04**
CUMULATIVE RISK		**9.36E-08**	**1.88E-04**		**1.37E-06**	**7.86E+00**	**1.47E-06**	**7.86E+00**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
GRO: Gasoline range organic
DRO: Diesel range organic
ORO: Oil range organic
ug/L: Micrograms per liter
ug/kg: Micrograms per kilogram

Table 7B-10(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 6B: GKN Facility, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
1,1-Dichloroethane	3.0	NA	3.53E-08	NA	1.18E-08	NA	5.21E-08	---	---	---	---	---	NA	9.92E-08
1,1-Dichloroethene	2.9	8.61E-12	1.12E-07	9.57E-12	1.24E-07	3.11E-11	2.18E-07	8.0	2.42E-08	3.14E-04	2.31E-11	1.62E-07	2.43E-08	3.14E-04
1,1,2-Trichloro-1,2,2-trifluoroethane	---	---	---	---	---	---	---	640	NA	NA	NA	4.81E-07	NA	4.81E-07
1,2,3-Trimethylbenzene	---	---	---	---	---	---	---	0.7	NA	NA	NA	8.80E-08	NA	8.80E-08
1,2,4-Trimethylbenzene	---	---	---	---	---	---	---	3.4	NA	NA	NA	5.94E-07	NA	5.94E-07
Acetone	30	NA	1.03E-07	NA	1.09E-07	NA	2.57E-07	---	---	---	---	---	NA	4.70E-07
Benzene	---	---	---	---	---	---	---	13	2.56E-09	2.06E-03	1.94E-12	2.76E-06	2.57E-09	2.07E-03
Bromomethane	---	---	---	---	---	---	---	14	NA	7.87E-04	NA	3.80E-06	NA	7.91E-04
cis-1,2-Dichloroethene	87	NA	3.02E-07	NA	3.35E-06	NA	1.70E-05	582	NA	NA	NA	1.71E-05	NA	3.77E-05
Dichlorodifluoromethane	---	---	---	---	---	---	---	35	NA	4.66E-05	NA	2.16E-06	NA	4.88E-05
Ethylbenzene	63	NA	2.18E-07	NA	2.23E-07	NA	1.95E-07	---	---	---	---	---	NA	6.37E-07
Methyl ethyl ketone (MEK)	11.8	NA	6.84E-09	NA	7.59E-09	NA	2.65E-08	---	---	---	---	---	NA	4.09E-08
Methyl tert-butyl ether (MTBE)	---	---	---	---	---	---	---	32	1.48E-10	3.66E-06	2.59E-14	6.02E-09	1.48E-10	3.66E-06
Methylene chloride	6.2	2.32E-13	3.61E-08	2.58E-13	4.01E-08	3.87E-13	1.92E-08	13	2.10E-09	3.27E-04	8.11E-14	4.01E-09	2.10E-09	3.27E-04
Tetrachloroethene	5.47	1.42E-13	1.91E-08	1.57E-12	2.12E-07	3.24E-13	9.79E-08	20	1.54E-08	2.08E-03	3.84E-13	1.16E-07	1.54E-08	2.08E-03
Toluene	2,448	NA	4.27E-07	NA	4.74E-06	NA	2.69E-05	---	---	---	---	---	NA	3.21E-05
trans-1,2-Dichlorobenzene	9	NA	3.47E-08	NA	1.93E-08	NA	5.17E-08	---	---	---	---	---	NA	1.06E-07
trans-1,2-Dichloroethene	36	NA	6.28E-08	NA	6.97E-07	NA	4.34E-06	58	NA	NA	NA	1.33E-06	NA	6.43E-06
Trichloroethene	21	1.91E-15	2.02E-09	1.27E-12	1.35E-06	2.77E-12	3.25E-06	112	6.23E-09	6.60E-03	4.55E-12	5.34E-06	6.23E-09	6.61E-03
Vinyl chloride	27	2.54E-13	3.12E-09	2.82E-10	3.46E-06	8.54E-10	6.99E-06	149	6.53E-07	8.01E-03	7.61E-10	6.22E-06	6.55E-07	8.03E-03
Xylenes, Total	202	NA	3.53E-08	NA	3.60E-08	NA	8.05E-07	---	---	---	---	---	NA	8.76E-07
Aroclor 1254	100	4.65E-10	8.14E-04	1.11E-09	1.94E-03	1.75E-13	3.06E-07	296	NA	NA	NA	NA	1.57E-09	2.75E-03
Acenaphthene	721	NA	4.19E-06	NA	4.66E-06	NA	2.92E-07	---	---	---	---	---	NA	9.14E-06
Acenaphthylene	29	NA	5.62E-07	NA	1.87E-07	NA	1.07E-08	---	---	---	---	---	NA	7.60E-07
Benzo(a)anthracene	103	1.62E-10	NA	4.16E-10	NA	1.83E-12	NA	126	2.36E-05	NA	8.64E-11	NA	2.36E-05	NA
Benzo(b)fluoranthene	102	1.61E-10	NA	4.12E-10	NA	1.38E-12	NA	---	---	---	---	---	5.74E-10	NA
Chrysene	159	2.51E-12	NA	6.42E-12	NA	3.70E-14	NA	---	---	---	---	---	8.97E-12	NA
Fluoranthene	146	NA	4.24E-07	NA	7.07E-07	NA	1.11E-08	---	---	---	---	---	NA	1.14E-06
Fluorene	109	NA	9.50E-07	NA	1.06E-06	NA	3.33E-08	---	---	---	---	---	NA	2.04E-06
Phenanthrene	17	NA	6.59E-07	NA	2.20E-07	NA	8.36E-09	---	---	---	---	---	NA	8.87E-07
Pyrene	136	NA	5.27E-07	NA	1.76E-06	NA	1.39E-08	---	---	---	---	---	NA	2.30E-06
Organics Total Risk		**8.00E-10**	**8.22E-04**	**2.24E-09**	**1.96E-03**	**8.92E-10**	**6.09E-05**		**2.43E-05**	**2.02E-02**	**8.77E-10**	**4.02E-05**	**2.43E-05**	**2.31E-02**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	---	---	---	---	885	NA	NA	NA	8.60E-06	NA	8.60E-06
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	55	NA	NA	NA	1.58E-05	NA	1.58E-05
Aromatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	55	NA	NA	NA	6.22E-07	NA	6.22E-07
TPH-GRO	**1,835**	**NA**	**NA**	**NA**	**8.34E-06**	**NA**	**1.08E-05**	**996**	**NA**	**NA**	**NA**	**2.50E-05**	**NA**	**4.42E-05**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	2.38E-03	NA	2.38E-03
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	1.03E-02	NA	1.03E-02
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	9.72E-02	NA	9.72E-02
Aromatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	2.87E-05	NA	2.87E-05
Aromatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	1.99E-05	NA	1.99E-05
Aromatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	5,575	NA	NA	NA	1.51E-05	NA	1.51E-05
TPH-DRO	**137,545**	**NA**	**3.03E-04**	**NA**	**9.22E-04**	**NA**	**2.64E-04**	**33,451**	**NA**	**NA**	**NA**	**1.10E-01**	**NA**	**1.11E-01**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	75	NA	NA	NA	1.31E-03	NA	1.31E-03
Aromatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	75	NA	NA	NA	1.20E-07	NA	1.20E-07
TPH-ORO	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**150**	**NA**	**NA**	**NA**	**1.31E-03**	**NA**	**1.31E-03**
TPH Total Risk		**NA**	**3.03E-04**	**NA**	**9.31E-04**	**NA**	**2.75E-04**		**NA**	**NA**	**NA**	**1.11E-01**	**NA**	**1.13E-01**

Table 7B-10(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 6B: GKN Facility, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
Arsenic	14,266	3.55E-10	5.53E-05	1.13E-07	1.75E-02	1.87E-10	2.91E-06	108	NA	NA	NA	NA	1.13E-07	1.76E-02
Barium	---	---	---	---	---	---	---	5,440	NA	NA	NA	NA	NA	NA
Cadmium	481	NA	1.12E-05	NA	3.73E-04	2.65E-12	5.90E-08	1,177	NA	NA	NA	NA	2.65E-12	3.84E-04
Chromium	---	---	---	---	---	---	---	412	NA	NA	NA	NA	NA	NA
Mercury	42	NA	1.65E-07	NA	8.23E-06	NA	1.98E-04	1.2	NA	NA	NA	3.29E-06	NA	2.10E-04
Selenium	920	NA	2.14E-05	NA	7.13E-05	NA	9.89E-07	---	---	---	---	---	NA	9.37E-05
Antimony	3,964	NA	1.15E-04	NA	3.84E-03	NA	4.26E-06	---	---	---	---	---	NA	3.96E-03
Beryllium	937	6.69E-10	5.45E-06	2.23E-10	1.82E-06	6.89E-12	1.01E-08	---	---	---	---	---	8.99E-10	7.27E-06
Cobalt	8,404	NA	4.88E-04	NA	1.63E-04	7.21E-11	9.03E-05	---	---	---	---	---	7.21E-11	7.42E-04
Copper	19,350	NA	5.62E-06	NA	1.87E-04	NA	4.14E-06	---	---	---	---	---	NA	1.97E-04
Manganese	1,084,100	NA	2.70E-03	NA	3.00E-03	NA	4.74E-03	6,400	NA	NA	NA	NA	NA	1.04E-02
Nickel	28,150	NA	8.18E-07	NA	5.45E-05	2.07E-11	3.02E-05	---	---	---	---	---	2.07E-11	8.55E-05
Zinc	52,140	NA	2.02E-06	NA	1.68E-05	NA	1.06E-08	---	---	---	---	---	NA	1.89E-05
Metals Total Risk		**1.02E-09**	**3.41E-03**	**1.13E-07**	**2.52E-02**	**2.90E-10**	**5.07E-03**		**NA**	**NA**	**NA**	**3.29E-06**	**1.14E-07**	**3.37E-02**
CUMULATIVE RISK		**1.82E-09**	**4.53E-03**	**1.15E-07**	**2.81E-02**	**1.18E-09**	**5.41E-03**		**2.43E-05**	**2.02E-02**	**8.77E-10**	**1.11E-01**	**2.44E-05**	**1.70E-01**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
GRO: Gasoline range organic
DRO: Diesel range organic
ORO: Oil range organic
ug/L: Micrograms per liter
ug/kg: Micrograms per kilogram

Table 9B-11(b)
Calculation of Individual Excess Lifetime Cancer Risk (IELCR) and Hazard Quotient (HQ) for a Future Construction Worker
Sub-area 8B: Office Complex North, Boeing Tract 1, St. Louis, Missouri

COCs	Average Soil Conc.	Dermal Contact with Soil		Accidental Ingestion of Soil		Outdoor Inhalation of Vapors and Particulates from Soil		Average GW Conc. (ug/L)	Dermal Contact with Groundwater		Outdoor Inhalation of Vapors from Groundwater		Sum of IELCR	Sum of HQ (HI)
	(ug/kg)	IELCR	HQ	IELCR	HQ	IELCR	HQ		IELCR	HQ	IELCR	HQ		
Methyl ethyl ketone (MEK)	11	NA	6.54E-09	NA	7.27E-09	NA	2.53E-08	---	---	---	---	---	NA	3.91E-08
Benzo(b)fluoranthene	66	1.04E-10	NA	2.67E-10	NA	8.95E-13	NA	---	---	---	---	---	3.72E-10	NA
Chrysene	44	6.93E-13	NA	1.78E-12	NA	1.02E-14	NA	---	---	---	---	---	2.48E-12	NA
Organics Total Risk		**1.05E-10**	**6.54E-09**	**2.68E-10**	**7.27E-09**	**9.05E-13**	**2.53E-08**		**NA**	**NA**	**NA**	**NA**	**3.74E-10**	**3.91E-08**
Aliphatics > nC6 to nC8 (TX1006)	---	---	---	---	---	---	---	83	NA	NA	NA	4.35E-07	NA	4.35E-07
Aliphatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	83	NA	NA	NA	1.28E-05	NA	1.28E-05
Aromatics > nC8 to nC10 (TX1006)	---	---	---	---	---	---	---	83	NA	NA	NA	5.04E-07	NA	5.04E-07
TPH-GRO	---	---	---	---	---	---	---	**250**	**NA**	**NA**	**NA**	**1.37E-05**	**NA**	**1.37E-05**
Aliphatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	467	NA	NA	NA	1.07E-04	NA	1.07E-04
Aliphatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	9,340	NA	NA	NA	9.29E-03	NA	9.29E-03
Aliphatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	28,019	NA	NA	NA	2.63E-01	NA	2.63E-01
Aromatics > nC10 to nC12 (TX1006)	---	---	---	---	---	---	---	467	NA	NA	NA	1.30E-06	NA	1.30E-06
Aromatics > nC12 to nC16 (TX1006)	---	---	---	---	---	---	---	3,736	NA	NA	NA	7.29E-06	NA	7.29E-06
Aromatics > nC16 to nC21 (TX1006)	---	---	---	---	---	---	---	7,472	NA	NA	NA	1.17E-05	NA	1.17E-05
TPH-DRO	---	---	---	---	---	---	---	**49,500**	**NA**	**NA**	**NA**	**2.72E-01**	**NA**	**2.72E-01**
Aliphatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	22,857	NA	NA	NA	2.14E-01	NA	2.14E-01
Aromatics > nC21 to nC35 (TX1006)	---	---	---	---	---	---	---	9,143	NA	NA	NA	1.33E-05	NA	1.33E-05
TPH-ORO	---	---	---	---	---	---	---	**32,000**	**NA**	**NA**	**NA**	**2.14E-01**	**NA**	**2.14E-01**
TPH Total Risk		**NA**	**NA**	**NA**	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**4.86E-01**	**NA**	**4.86E-01**
Arsenic	---	---	---	---	---	---	---	15	NA	NA	NA	NA	NA	NA
Chromium	---	---	---	---	---	---	---	51	NA	NA	NA	NA	NA	NA
Mercury	---	---	---	---	---	---	---	---	---	---	---	---	NA	NA
Organics Total Risk		**NA**	**NA**	**NA**	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
CUMULATIVE RISK		**1.05E-10**	**6.54E-09**	**2.68E-10**	**7.27E-09**	**9.05E-13**	**2.53E-08**		**NA**	**NA**	**NA**	**4.86E-01**	**3.74E-10**	**4.86E-01**

Notes:
NA: Not available
---: Risk evaluation was not performed.
HI: Hazard index
TPH: Total petroleum hydrocarbon
DRO: Diesel range organic
GRO: Gasoline range organic
ORO: Oil range organic
ug/kg: Micrograms per kilogram
ug/L: Micrograms per liter

Table 3-2 Groundwater Sample Analytical Results for Risk Area 6B, Boeing Tract 1, Interim Action Remedial Excavation, Boeing, Hazelwood, Missouri

	Sample ID	RC13		RC13		RC13		RC14		RC14		RC14		RC15		RC15		
	Collect Date	7/29/2005		9/29/2005		4/5/2006		7/29/2005		9/29/2005		4/5/2006		9/29/2005		4/5/2006		
Method	Parameter	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	
Volatile Organic Compounds (VOCs)																			
8260B	Acetone	µg/l	<25		<25		<50		<25		<25		<50		170		<50		
8260B	Benzene	µg/l	<1.0		<1.0		<1.0		<1.0		1.4		1.3		<1.0		<1.0		
8260B	tert-Butylbenzene	µg/l	<1.0		<1.0		<1.0		2.4		3.1		4		<1.0		<1.0		
8260B	1,1-Dichloroethane	µg/l	<1.0		1.1		<1.0		11		26		27		<1.0		<1.0		
8260B	1,2-Dichloroethane	µg/l	<1.0		<1.0		<1.0		3.6		6.1		5.4		<1.0		<1.0		
8260B	1,1-Dichloroethene	µg/l	<1.0		<1.0		<1.0		1.2		2.1		2.5		<1.0		<1.0		
8260B	cis-1,2-Dichloroethene	µg/l	3.7		12		3		1,800		1,400	E	1,100	E	4.1		6.5		
8260B	trans-1,2-Dichloroethene	µg/l	<1.0		<1.0		<1.0		7.6		16		11		<1.0		<1.0		
8260B	Trichloroethene	µg/l	<1.0		<1.0		<1.0		33		51	E	33		<1.0		<1.0		
8260B	Vinyl chloride	µg/l	4.7		17		<1.0		220		390	E	280	E	1.9		<1.0		
Total Petroleum Hydrocarbon (TPH)																			
8260B	Gas Range Organics (GRO)	µg/l	<500		<500		<500		2,400	J5	1,800		1,500		<500		<500		
8270	Diesel Range Organics (DRO)	µg/l	<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		
8270	Oil Range Organics (ORO)	µg/l	<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		<1,000		
Semi-Volatile Organic Compounds (SVOCs)																			
8270C	Acenaphthene	µg/l	<10		1.4		<10		<10		<1.0		<10		<1.0		<10		

Notes:

Qual - data qualifier
Bold - Indicates a detection
NA - Constituent not analyzed
µg/l - micrograms per liter
< - Constituent not detected above concentration value listed
ND - Constituent not detected
E - GTL (EPA) - Greater than upper calibration limit: Actual value is known to be greater than the upper calibration range
J5 - The sample matrix interfered with the ability to make any accurate determination; spike value is high
* *from Risk-Based Corrective Action Report, Boeing Tract 1* (Risk Assessment & Management (RAM) Group, September 2004)

Created by: LMS Approved by: DLB
Reviewed by: _____ 4/2006

Table 3-4 Groundwater Sample Analytical Results for Risk Area 8B, Boeing Tract 1, Interim Action Remedial Excavation, Boeing, Hazelwood, Missouri

		Sample ID	B220N4		B220N4		B220N5		B220N5		B220N6		B220N6		
		Collect Date	7/29/2005		9/29/2005		4/11/2006		7/29/2005		9/30/2005		4/11/2006		
Method	Parameter	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	Value	Qual	
Volatile Organic Compounds (VOCs)															
8260B		µg/l	ND		ND		ND		ND		ND		ND		
Total Petroleum Hydrocarbon (TPH)															
8260B	Gas Range Organics (GRO)	µg/l	<500		<500		<500		<500		<500		<500		250
8270	Diesel Range Organics (DRO)	µg/l	<1,000		<1,000		<1000		<1,000		<1,000		<1,000		1,000
8270	Oil Range Organics (ORO)	µg/l	<1,000		<1,000		<1000		<1,000		<1,000		<1,000		1,000

Notes:

Qual - data qualifier

µg/l - micrograms per liter

Bold - Indicates a detection

< - Constituent not detected above concentration value listed

ND - Constituent not detected

-- - not applicable

* *from Risk-Based Corrective Action Report, Boeing Tract 1* (Risk Assessment & Management (RAM) Group, September 2004)

Created by: LMS Approved by: DLB
Reviewed by: _____ Date: 5/4/2006

Table 3-6 Groundwater Sample Analytical Results for Risk Area 3A, Boeing Tract 1, Interim Action Remedial Excavation, Boeing, Hazelwood, Missour.

Sample ID			B42N6		B42N6	B42N6		B42N7	B42N7		B42N8		B42N8 DUP	
Collect Date			10/14/2005		12/1/2005	4/11/2006		10/14/2005	12/1/2005	4/11/2006	12/1/2005		4/11/2006	4/11/2006
Methods	Parameter	Units	Value	Qual	Value Qual	Value	Qual	Value Qual	Value Qual	Value Qual	Value	Qual	Value Qual	Value Qual
Volatile Organic Compounds (VOCs)														
8260B	Acetone	µg/l	NA		<25	<50		NA	<25	<50	**200**	**J6**	**66**	<50
8260B	Benzene	µg/l	**1.1**		**2.2**	**1.7**		1.1	<1.0	<1.0	<1.0		<1.0	<1.0
8260B	sec-Butylbenzene	µg/l	NA		**1.6**	<1.0		NA	<1.0	<1.0	<1.0		<1.0	<1.0
8260B	cis-1,2-Dichloroethene	µg/l	NA		**220**	**E**	**170**	**E**	NA	**12**	**5.4**	**13**		**5.2**	**4.6**
8260B	trans-1,2-Dichloroethene	µg/l	NA		**8.4**	<1.0		NA	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0
8260B	Isopropylbenzene	µg/l	NA		**5.7**	**5.1**		NA	**3**	<1.0	<1.0	<1.0		<1.0	<1.0
8260B	n-Propylbenzene	µg/l	NA		**4.2**	**4.2**		NA	**1.4**	<1.0	<1.0	<1.0		<1.0	<1.0
8260B	Vinyl chloride	µg/l	NA		**45**	**47**		NA	**8.1**	**8.3**	<1.0	<1.0		<1.0	<1.0
8260B	Xylenes, Total	µg/l	<3.0		<3.0	<3.0		<3.0	<3.0	<3.0	<3.0	<3.0		<3.0	<3.0
Total Petroleum Hydrocarbon (TPH)														
8260B	Gas Range Organics (GRO)	µg/l	**1,100**		**1,000**	**590**		<500	<500	<500	<500	<500		<500	<500
8270	Diesel Range Organics (DRO)	µg/l	<1,000		<1,000	<1,000		<1,000	<1,000	<1,000	<1,000	<1,000		<1,000	<1,000
8270	Oil Range Organics (ORO)	µg/l	<1,000		<1,000	<1,000		<1,000	<1,000	<1,000	<1,000	<1,000		<1,000	<1,000

Notes:

Qual - data qualifier
µg/l - micrograms per liter
NA - Constituent not analyzed
Bold - Indicates a detection
< - Constituent not detected above concentration value listed
ND - Constituent not detected
E - GTL (EPA) - Greater than upper calibration limit; Actual value is known to be greater than the upper calibration range.
J6 - estimate - sample matrix interfered with the ability to make any accurate determination; spike value is low
* *from Risk-Based Corrective Action Report, Boeing Tract 1* (Risk Assessment & Management (RAM) Group, September 2004)

Created by: LMS Approved by: DCB
Reviewed by: _____ Date: 5-4-2006

Table 3-8 Groundwater Sample Analytical Results for Risk Area 3E, Boeing Tract 1, Interim Action Remedial Excavation, Boeing, Hazelwood, Missouri

		Sample ID	B2E3	B2E3	B2E3	B2E4	B2E4	B2E4	B2E5	B2E5	Risk Attainment Area Average Groundwater*
		Collect Date	10/14/2005	12/1/2005	4/5/2006	10/14/2005	12/1/2005	4/5/2006	12/1/2005	4/5/2006	
Method	Parameter	Units	Value Qual	Value Qual	Value Qual	Value Qual	Value Qual	Value Qual	Value Qual	Value Qual	
Volatile Organic Compounds (VOCs)											
8260B	Acetone	µg/l	NA	<25	<50	NA	<25	<50	<25	**50**	540
8260B	Benzene	µg/l	**9.2**	**5.5**	4.8	<1.0	**1.9**	<1.0	<1.0	<1.0	ND
8260B	n-Butylbenzene	µg/l	NA	**1.1**	<1.0	NA	**1.2**	<1.0	<1.0	**1.4**	ND
8260B	sec-Butylbenzene	µg/l	NA	**1.2**	<1.0	NA	**1.7**	<1.0	<1.0	**1.7**	ND
8260B	tert-Butylbenzene	µg/l	NA	<1.0	<1.0	NA	<1.0	<1.0	**12**	<1.0	ND
8260B	Ethylbenzene	µg/l	**57 E**	**28**	12	1.6	**8.6**	**3.6**	**12**	**67**	1,245
8260B	Isopropylbenzene	µg/l	NA	**20**	5.5	NA	**14**	**9.1**	**7.2**	**18**	ND
8260B	p-Isopropyltoluene	µg/l	NA	<1.0	<1.0	NA	<1.0	<1.0	<1.0	**2**	ND
8260B	2-Butanone (MEK)	µg/l	NA	<10	<10	NA	<10	<10	<10	**20**	ND
8260B	4-Methyl-2-pentanone (MIBK)	µg/l	NA	<10	<10	NA	<10	<10	**13**	**10**	ND
8260B	Naphthalene	µg/l	**44 J3**	**21 J3**	28	<5.0 J3	**6.2 J3**	**5.8**	**18 J3**	**61**	930
8260B	n-Propylbenzene	µg/l	NA	**30**	4.8	NA	**26**	**15**	**6.6**	**18**	480
8260B	1,2,4-Trimethylbenzene	µg/l	NA	<1.0	<1.0	NA	**3.6**	**2.7**	**99 E**	**160 E**	2,500
8260B	1,2,3-Trimethylbenzene	µg/l	NA	**5.8**	5.1	NA	**16**	**7**	**49**	**70**	ND
8260B	Xylenes, Total	µg/l	**46**	**18**	18	7.3	**14**	**11**	**160 E**	**240 E**	2,288
Total Petroleum Hydrocarbon (TPH)											
8260B	Gas Range Organics (GRO)	µg/l	**2,000**	**2,100**	530	960	**4,600**	**1,600**	**1,900**	**3,500**	19,500
8270	Diesel Range Organics (DRO)	µg/l	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	50,025
8270	Oil Range Organics (ORO)	µg/l	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	4,880

Notes:

Qual - data qualifier
µg/l - micrograms per liter
J3 - estimate - the associated batch QC was outside the established quality control range for precision
E - GTL (EPA) - Greater than upper calibration limit: Actual value is known to be greater than the upper calibration range
Bold - Indicates a detection
< - Constituent not detected above concentration value listed
NA - Constituent not analyzed
ND - Constituent not detected
* *from Risk-Based Corrective Action Report, Boeing Tract 1* (Risk Assessment & Management (RAM) Group, September 2004)

ENVIRONMENTAL COVENANT

This Environmental Covenant is entered into by and between The City of St. Louis, a municipal corporation of the State of Missouri ("Owner"), and McDonnell Douglas Corporation, a wholly-owned subsidiary of The Boeing Company, and The Boeing Company ("Holders"), pursuant to the Missouri Environmental Covenants Act, Sections 260.1000 through 260.1039, RSMo.

RECITALS

WHEREAS, Owner, whose mailing address is _____, is the owner in fee simple of certain real property commonly known and numbered as _____, and legally described as: **[insert "legal description of the real property"]** the "Property;"

WHEREAS, Owner desires to grant to the Holders, whose mailing address is 100 North Riverside Plaza, Chicago, Illinois 60606-1596, this Environmental Covenant for the purpose of subjecting the Property to certain activity and use limitations as provided in the Missouri Environmental Covenants Act;

WHEREAS, the Property is the subject of RCRA Corrective Action pursuant to the requirements of Hazardous Waste Permit No. OSO 62284002, issued by the Missouri Department of Natural Resources (the "Permit"); and

WHEREAS, the Permit required environmental investigation of the Property, which investigation revealed the presence of groundwater and soil contamination at various portions of the Property; the results of which are documented in a Remedial Facility Investigation Report, dated _____; and

WHEREAS, the Permit required preparation of a Corrective Measures Study, which evaluated and proposed various remedial and other measures to remove, contain and otherwise address environmental contamination documented by the Remedial Facility Investigation Report; and

WHEREAS, in support of the Corrective Measures Study, a risk assessment was performed to determine the clean-up levels for the contamination identified in the Remedial Facility Investigation Report consistent with the Property's current and anticipated future use as an airport related maintenance and manufacturing facility; the results of which are documented in a Risk-Based Corrective Action Report, dated _____; and

WHEREAS, the Missouri Department of Natural Resources has reviewed and approved the Remedial Facility Investigation Report, the Corrective Measures Study, and the Risk-Based Corrective Action Report and has determined that this Environmental Covenant will support completion of the RCRA Corrective Action requirements of the

Permit by limiting future use of the property consistent with the assumptions underlying the Risk-Based Corrective Action Report and the Corrective Measures Study; and

WHEREAS, The term "Department" shall have the meaning given it in Section 260.1003(2) RSMo.

NOW THEREFORE, Owner, Holders, and the Department agree to the following:

1. Parties.
The Owner, the Holder and the Department are parties to this Environmental Covenant and may enforce it as provided for in Section 260.1030, RSMo.

2. Activity and Use Limitations.
As part of the implementation of institutional controls to support completion of the corrective actions required by the Permit, Owner hereby subjects the Property to, and agrees to comply with, the following activity and use limitations:

A. Restriction on Residential Use of the Property: The Property shall not be used, and the Owner shall not permit use of the Property, for single-family dwellings which individual residents may inhabit for 350 days or more per year for a cumulative period of 24 hours or more, or in the case of a child resident, for 350 days or more per year for a cumulative period of 6 years or more. If any Owner desires in the future to use the Property for a prohibited residential purpose, the Owner shall notify the Department 120 days in advance of such use and obtain Department approval for such use subject to conducting any further analyses and, as necessary, response action(s) as the Department may require as a condition of its approval. The Property may not be used in a manner that conflicts with this restriction.

B. Restriction on Use of Groundwater: The Owner of the Property shall not install or maintain, and shall not permit the installation and maintenance of, groundwater extraction wells on the Property for use as a drinking water supply or for other domestic purposes which may result in human ingestion of the groundwater or dermal exposure to the groundwater. This restriction shall not preclude installation and maintenance of groundwater wells on the Property for purposes of investigating, characterizing, or monitoring the groundwater. If any Owner desires in the future to use the groundwater for a prohibited purpose, the Owner shall notify the Department 120 days in advance of such use and obtain Department approval for such use subject to conducting any further analyses and, as necessary, response action(s) as the Department may require as a condition of its approval. The Property may not be used in a manner that conflicts with this restriction.

C. Restriction on Agricultural Use of the Property. The Property shall not be used, and the Owner shall not permit use of the Property, for agricultural or other uses which may result in routine dermal contact by individual non-residential

workers with surficial soils (defined as soils located zero to three feet below the ground surface) for 250 days or more for a cumulative period of 25 years or more. This restriction shall not preclude construction work on the Property notwithstanding that construction workers may have routine dermal contact with surficial soils, nor does this restriction preclude work involving grounds maintenance, installation and maintenance of landscaping and ornamental gardens, and/or installation and maintenance of irrigation systems associated with the foregoing. If any Owner desires in the future to use the Property for a prohibited agricultural purpose, the Owner shall notify the Department 120 days in advance of such use and obtain Department approval for such use subject to conducting any further analyses and, as necessary, response action(s) as the Department may require as a condition of its approval. The Property may not be used in a manner that conflicts with this restriction.

3. Running with the Land.
This Environmental Covenant shall be binding upon Owner and its successors, assigns, and Transferees in interest, and shall run with the land, as provided in Section 260.1012, RSMo, subject to amendment or termination as set forth herein. The term "Transferee," as used in this Environmental Covenant, shall mean any future owner of any interest in the Property or any portion thereof, including, but not limited to, owners of an interest in fee simple, mortgagees, easement holders, and/or lessees.

4. Location of Administrative Record for the Environmental Response Project.
The administrative record for the environmental response project for the Property is located at [TBD].

5. Enforcement.
Compliance with this Environmental Covenant may be enforced as provided in Section 260.1030, RSMo. Failure to timely enforce compliance with this Environmental Covenant or the activity and use limitations contained herein by any party shall not bar subsequent enforcement by such party and shall not be deemed a waiver of the party's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict any person from exercising any authority under any other applicable law.

6. Right of Access.
Owner hereby grants to each of the Holders, the Department and their respective agents, contractors, and employees, the right of access at all reasonable times to the Property for implementation, monitoring or enforcement of this Environmental Covenant. Nothing herein shall be deemed to limit or otherwise affect the Department's rights of access and entry under federal or state law.

~~**7. (May be optional depending on the Site.) Compliance Reporting.**~~
~~Owner/Transferee shall submit to the Holder and the Department, by no later than January 31st of each year, documentation verifying that the activity and use limitations imposed hereby were in place and complied with during the preceding calendar year.~~

~~Such reports shall be sent to the Holder and the Department at the address that appears in paragraph 18 (Notice) below. The Holder and the Department may change their/its mailing address by written notice to Owner/Transferee. The Compliance Report shall include the following statement, signed by Owner/Transferee: To the best of my knowledge, after thorough investigation, I certify that the information contained in or accompanying this submission is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.~~ [PROPOSE TO DELETE THIS REQUIREMENT AS UNECCESSARY GIVEN THE USE LIMITATIONS]

8. Additional Rights.
None.

9. Notice upon Conveyance.
Each instrument hereafter conveying any interest in the Property or any portion of the Property shall contain a notice of the activity and use limitations set forth in this Environmental Covenant, and provide the recording reference for this Environmental Covenant. The notice shall be substantially in the following form: THE INTEREST CONVEYED HEREBY IS SUBJECT TO AN ENVIRONMENTAL COVENANT, DATED _____,20__, RECORDED IN THE OFFICE OF THE RECORDER OF DEEDS OF _____ COUNTY, _____, ON _____, 20__, AS DOCUMENT ____, BOOK___, PAGE ____. Owner/Transferee shall notify the Holder and the Department within ten (10) days following each conveyance of an interest in any portion of the Property. The notice shall include the name, address, and telephone number of the Transferee, and a copy of the deed or other documentation evidencing the conveyance.

10. Notification Requirement.
Owner shall notify the Department following transfer of any interest in the Property or of any changes in use of the Property inconsistent with the Activity and Use Limitations specified in paragraph 2 above.

11. Representations and Warranties.
Owner hereby represents and warrants to the Holders and the Department that Owner has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all of Owner's obligations hereunder; that Owner is the sole owner of the Property and holds fee simple title, which is free, clear and unencumbered; to the extent that other interests in the Property exist, Owner has agreed to subordinate such interest to this Environmental Covenant, pursuant to Section 260.1006.4, RSMo, and the subordination agreement (attached hereto as Exhibit __ or recorded at _____); that Owner has identified all other parties who hold any interest (e.g., encumbrance) in the Property and notified such parties of Owner's intention to enter into this Environmental Covenant; and that this Environmental Covenant will not materially violate or contravene or constitute a material default under any other agreement, document or instrument to which Owner is a party or by which Owner may be bound or affected.

12. Amendment or Termination.
This Environmental Covenant may be amended or terminated by consent signed by the Department and the Holders. Signatories to this Environmental Covenant other than Department and the Holders hereby waive the right to consent to any amendment to, or termination of, this Environmental Covenant. Within thirty (30) days of signature by all requisite parties on any amendment or termination of this Environmental Covenant, Owner/Transferee shall file such instrument for recording with the office of the recorder of the county in which the Property is situated, and within thirty (30) days of the date of such recording, Owner/Transferee shall provide a file- and date-stamped copy of the recorded instrument to the Department and the Holder.

13. Severability.
If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

14. Governing Law.
This Environmental Covenant shall be governed by and interpreted in accordance with the laws of the State of Missouri.

15. Recordation.
Within thirty (30) days after the date of the final required signature upon this Environmental Covenant, Owner shall record this Environmental Covenant with the office of the recorder of the county in which the Property is situated.

16. Effective Date.
The effective date of this Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded with the office of the recorder of the county in which the Property is situated.

17. Distribution of Environmental Covenant.
Within thirty (30) days following the recording of this Environmental Covenant, or any amendment or termination of this Environmental Covenant, Owner/Transferee shall, in accordance with Section 260.1018, RSMo, distribute a file- and date-stamped copy of the recorded Environmental Covenant to: (a) each signatory hereto; (b) each person holding a recorded interest in the Property; (c) each person in possession of the Property; (d) each municipality or other unit of local government in which the Property is located; and (e) any other person designated by the Department.

18. Notice.
Any document or other item required by this Environmental Covenant to be given to another party hereto shall be sent to:

If to Owner:
[name]
[address]

If to Holder:
[name]
[address]

If to Department:
[name]
[address]

The undersigned represent and certify that they are authorized to execute this Environmental Covenant.

IT IS SO AGREED:

FOR OWNER

By: _____ Date: _____
Name (print):
Title:
Address:
[Consult Section 442.210, RSMo for acknowledgement requirements.]
STATE OF _____)
)
COUNTY OF _____)
On this ___ day of _____, 20__, before me, a Notary Public in and for said state, personally appeared (Name), (Title) of _____(Corporate Name), known to me to be the person who executed the within Environmental Covenant on behalf of said corporation and acknowledged to me that he/she executed the same for the purposes therein stated.

_____
Notary Public

FOR HOLDERS
By: _____ Date: _____
Name (print):
Title:
Address:
STATE OF _____)
)
COUNTY OF _____)
On this ___ day of _____, 20__, before me, a Notary Public in and for said state, personally appeared (Name), (Title) of _____(Corporate Name),

known to me to be the person who executed the within Environmental Covenant in behalf of said corporation and acknowledged to me that he/she executed the same for the purposes therein stated.

_____
Notary Public

FOR DEPARTMENT
By: _____ Date: _____
Name (print):
Title:
Address:
STATE OF _____)
)
COUNTY OF _____)
On this ___ day of _____, 20__, before me, a Notary Public in and for said state, personally appeared (Name), (Title) of _____(Corporate Name), known to me to be the person who executed the within Environmental Covenant in behalf of said corporation and acknowledged to me that he/she executed the same for the purposes therein stated.

_____
Notary Public

STATE OF MISSOURI
Jeremiah W. (Jay) Nixon, Governor • Mark N. Templeton, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

March 12, 2010

CERTIFIED MAIL – 7004 1160 0000 8177 3278
RETURN RECEIPT REQUESTED

Mr. Joseph W. Haake, Group Manager
Environment, Health and Safety
The Boeing Company
P.O. Box 516
Dept. 107E, Bldg. 111, Mailcode S111-2491
St. Louis, MO 63166-0516

RE: Corrective Measures Study Work Plan for Boeing Tract I Extension Request
The Boeing Company, Hazelwood, Missouri
EPA ID# MOD000818963

Dear Mr. Haake:

This letter is to notify you that the Missouri Department of Natural Resources reviewed The Boeing Company's proposed Corrective Measures Study (CMS) work plan, dated December 17, 2009. The proposed work plan presents the procedures to be used during the Corrective Measures Study to identify, evaluate, and propose the necessary remedial alternatives to address the specific areas that present an unacceptable risk. The Boeing Company submitted the proposed work plan according to Code of Federal Regulations 40 CFR 264, incorporated by reference in Code of State Regulations 10 CSR 25-7.264, and McDonnell Douglas' Missouri Hazardous Waste Management Facility Part I Permit, Schedule of Compliance, Condition III., dated March 5, 1997.

We have the following comments and requests for additional information for your review and response. Please address the individual comments by submitting three copies of a revised work plan to the Missouri Department of Natural Resources within 30 days of receiving this letter.

If you have any questions regarding this letter or the enclosed comments, please contact me at the Missouri Department of Natural Resources, 7545 South Lindbergh, Suite 210, St. Louis, MO 63125, by telephone at (314) 416-2960 Ext. 256 or 1-800-361-4827, or by e-mail at christine.kump@dnr.mo.gov. Thank you.

Sincerely,

HAZARDOUS WASTE PROGRAM

for CKM

Christine Kump-Mitchell, P.E.
Environmental Engineer
Permits Section

CKM:sw

Enclosure

c: Ms. Christine Jump, Missouri State Coordinator, U.S. EPA Region VII
St. Louis Regional Office, Missouri Department of Natural Resources

Comments

1. The Boeing Company submitted a technical memorandum, via e-mail, entitled "Risk Evaluation of TPH for Indoor Inhalation Pathway, Boeing Tract 1 Facility, St. Louis, Missouri" dated January 12, 2010. The Missouri Department of Natural Resources approved this methodology for use at the Boeing facility in a letter dated February 4, 2010. Based on this methodology, it was determined that concentrations of total petroleum hydrocarbon (TPH) found in groundwater are not volatilizing into the soil vapor at concentrations that exceed risk. Therefore, it was determined that the proposed soil vapor sampling is not necessary at this time. Please remove all references to soil vapor sampling from the Corrective Measures Study (CMS) Work Plan.

2. **Executive Summary:** Please include a statement in the Executive Summary that the purpose of the additional activities is to help determine the applicability of individual remedial technologies for the site. A similar statement should also be included in Section 1.1.

3. **Section 1.2.3 Additional Investigation and Interim Actions, Page 1-3:** This section states "COCs that exceeded risk (benzo(a)anthracene at Sub-area 6B and TPH at all four Sub-areas) were not detected in any of the groundwater samples analyzed from the four Sub-areas during the two post excavation sampling events, therefore, additional groundwater sampling was not recommended." Please provide the sampling results from the post-excavation groundwater sampling.

4. **Section 1.2.3.1 Interim Action Remedial Excavation Completion Report, Boeing Tract 1, Page 1-3; and Section 1.2.3.2 Interim Measures Completion Report, Solid Waste Management Unit 17, Page 1-4:** These sections state that the RAM Group has recalculated the representative soil calculations for Sub-areas 6B, 3A, 3E, 8B, and 2B (SWMU 17) while excluding results for the soil sample locations that were removed during soil excavation activities. Please provide the revised representative soil calculations for these Sub-areas as well as a comparison to the old representative soil concentrations.

5. **Section 2.0 Approach for Investigation and Evaluation of Potential Remedies, Page 2-1:** This section discusses additional work that will be conducted to facilitate selection of a final remedy in the CMS Report. These additional activities include re-evaluation of risk based on more recent groundwater data and evaluation of plume stability and monitored natural attenuation. The Missouri Department of Natural Resources anticipates receiving an interim report presenting the results of these activities prior to receiving the CMS Report.

6. **Section 2.1.1 Re-evaluation of Risks, Page 2-1:** This section states that representative groundwater concentrations will be re-calculated to include data collected since 2004 and the resulting values will be used subsequently to re-calculate risks. What risks are going to be recalculated: risk to groundwater or indoor air via groundwater infiltration? Please specify.

7. **Section 2.1.3, Plume Stability and Monitored Natural Attenuation (MNA), Page 2-2:** This section states that the groundwater monitoring plan will include the end-point conditions to be met in order to cease groundwater monitoring. The U.S. Environmental Protection Agency Region VII policy requires groundwater cleanup criteria for Resource Conservation and Recovery Act sites to be set at maximum contaminant levels (MCLs). Where MCLs are not available, the Environmental Protection Agency Regional Screening Levels should be used. In the absence of both MCLs and Regional Screening Levels, as is the case for TPH, Missouri Risk-Based Corrective Action Default Target Levels may be used.

Appendix C: Proposed AUL Language

8. Appendix C includes a draft Environmental Covenant for the Boeing Tract 1 property. Specific comments regarding the Environmental Covenant and the proposed activity and use limitations will be provided separate from these CMS Work Plan comments.

STATE OF MISSOURI
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DEPARTMENT OF NATURAL RESOURCES
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February 4, 2010

Atul M. Salhotra, Ph.D.
RAM Group
5433 Westheimer, Suite 725
Houston, TX 77056

RE: Risk Evaluation of Total Petroleum Hydrocarbons for Indoor Inhalation Pathway
Boeing Tract 1 Facility, St. Louis, Missouri, EPA ID# MOD000818963

Dear Dr. Salhotra:

The Missouri Department of Natural Resources (Department) has reviewed the RAM Group's technical memorandum, Risk Evaluation of total petroleum hydrocarbons (TPH) for the Indoor Inhalation Pathway for the Boeing Tract 1 facility, St. Louis, Missouri, submitted via e-mail on January 12, 2010, and the Treatment of TPH in Risk Assessment presentation, presented to the Department on January 14, 2010. The subject memorandum presents: (1) issues related to the estimate of risk to TPH in soil and groundwater for the indoor inhalation pathway as presented in the *Departmental Missouri Risk Based Corrective Action Guidance* (MDNR, April 2006) and (2) the risk evaluation of TPH for the Indoor Inhalation Pathway at the Boeing Tract 1 facility in St. Louis, Missouri. The Department hereby approves the RAM Group's approach for evaluating TPH risk as it applies to the Boeing Tract 1 facility.

This letter is a facility-specific approval only and should not in any way be construed as approval to apply this methodology at other sites and does not constitute approval of overarching changes to the Missouri Risk-Based Corrective Action (MRBCA) guidance document. As you know, Mr. Tim Chibnall is the Department's contact for further discussions related to changes to MRBCA including issues related to the estimate of risk related to TPH in soil and groundwater for the Indoor Inhalation Pathway. While Mr. Chibnall has been consulted regarding the approach at the Boeing facility, and seems to be in general agreement, he has advised that the Department will conduct an 'internal review' to evaluate potential revisions to the MRBCA guidance before making any decisions regarding such revisions. This review will include, at a minimum, seeking input from the Department's laboratory and risk assessment support from the Department of Health and Senior Services. Mr. Chibnall will be in contact with you in this regard.

If you have any questions regarding this letter as it relates to the Boeing Tract 1 facility, please contact Christine Kump-Mitchell, P.E., of my staff at the Missouri Department of Natural Resources, 7545 South Lindbergh, St. Louis, MO 63125-4039, or by telephone at (314) 416-2960, Ext. 256 or 1-800-361-4827, or by e-mail at christine.kump@dnr.mo.gov. If you have specific questions regarding MRBCA, please contact Mr. Chibnall, at the Missouri Department of Natural Resources, Hazardous Waste Program, P.O. Box 176, Jefferson City, MO 65102-0176, or by telephone at (573) 522-1833, or by e-mail at tim.chibnall@dnr.mo.gov. Thank you.

Sincerely,

HAZARDOUS WASTE PROGRAM

Richard A. Nussbaum, P.E., R.G.
Chief, Permits Section

RAN:ckm

c: Mr. Joseph Haake, The Boeing Company
Mr. Curt Lueckenhoff, Environmental Services Program

RAM GROUP *The Risk Assessment & Management Group of Gannett Fleming, Inc.*

Transmitted by E-Mail

To: Joe Haake

From: Atul M. Salhotra, Ph.D.
Sungmi Moon, Ph.D.
Kendall G. Pickett

Date: January 12, 2010

RE: Risk Evaluation of TPH for Indoor Inhalation Pathway
Boeing Tract 1 Facility, St. Louis, Missouri

This memo presents (i) the issues related to the estimate of risk due to total petroleum hydrocarbons (TPHs) in soil and groundwater for indoor inhalation pathway as presented in the *Departmental Missouri Risk-Based Corrective Action (MRBCA) Technical Guidance* (MDNR, April 2006); and (ii) the risk evaluation of TPH for indoor inhalation pathway at the Boeing Tract 1 Facility in St. Louis, Missouri.

TPH Methodology in MRBCA Process

As per the *Departmental MRBCA Technical Guidance* (MDNR, April 2006), MRBCA process uses the following TPH methodology:

1. TPH-GRO (gasoline range organic), TPH-DRO (diesel range organic), and TPH-ORO (oil range organic) groups are considered to consist of the following eleven aliphatic and aromatic carbon fractions:

TPH-GRO		TPH-DRO		TPH-ORO	
Aliphatics	Aromatics	Aliphatics	Aromatics	Aliphatics	Aromatics
C6-C8 C8-C10	C8-C10	C10-C12 C12-C16 C16-C21	C10-C12 C12-C16 C16-C21	C21-C35	C21-C35

2. Representative soil and/or groundwater concentration of each carbon fraction is used to estimate vapor concentration of the corresponding carbon fraction using equilibrium conversion. The estimated vapor concentration is used to calculate the risk for each carbon fraction using a version of the Johnson and Ettinger (J&E) model included in the MDNR (April, 2006). Finally, the risks for TPH-GRO, TPH-DRO, and TPH-ORO are calculated as the sum of the risk of each carbon fraction.

3. The representative vapor concentration is estimated using the representative groundwater concentrations and Henry's law constant as shown in equation

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below:

$$C_v = H \times C_{gw} \times 1000$$

where,

C_v	=	Vapor concentration (mg/m^3)
H	=	Dimensionless Henry's law constant ((mg/L-air)/(mg/L-water))
C_{gw}	=	Groundwater concentration (mg/L)
1000	=	Unit conversion factor (L/m^3)

If the representative groundwater concentration of a carbon fraction exceeds the solubility of the carbon fraction, the calculated vapor concentration will exceed the saturated vapor concentration for that carbon fraction. Clearly, this is incorrect because the concentration cannot exceed the solubility or the saturated vapor concentration. Since risk is proportional to vapor concentration, above incorrect calculation will result in an overestimation of risk.

If the representative groundwater concentration exceeds the solubility, the representative groundwater concentration ought to be capped at the effective solubility and consequently the vapor concentration at the effective saturated vapor concentration. This restriction is not clearly discussed in the MDNR (April 2006) although it is included in the *MRBCA Process for Petroleum Storage Tanks* (MDNR, January 2004). Specifically, when evaluating the site with light non-aqueous phase liquid (LNAPL), Appendix B of the MDNR (January 2004) states the following:

"*In the forward mode of risk assessment, the effective soil vapor and dissolved concentrations can be used to calculate the risk due to indoor inhalation.....*"

4. Toxicity and physical/chemical properties of carbon fractions were obtained from the *TPH Criteria Working Group (TPHCWG) Series Volume 5: Human Health Risk-Based Evaluation of Petroleum Contaminated Sites: Implementation of the Working Group Approach.* (TPHCWG, June 1999). Table 1 presents the inhalation toxicity and physical/chemical properties of carbon fractions used for indoor inhalation pathway.

5. Table 1 indicates that inhalation toxicity values for the four carbon fractions (aliphatics C16-C21, aromatics C16-C21, aliphatics C21-C35, and aromatics C21-C35) are not available. Hence, risk due to these four fractions cannot be calculated for indoor inhalation pathway within the MRBCA process.

6. As per the MRBCA process, volatile compounds have molecular weight smaller than 200 and dimensionless Henry's law constant greater than 4.2×10^{-4}. Based on this definition, three fractions (aliphatics C16-C21, aliphatics C21-C35, and aromatics C21-C35) are not volatile. Therefore, it is reasonable not to consider

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these three fractions for indoor inhalation pathway.

7. Although not discussed in the MRBCA process, it is also reasonable to exclude aromatics C16-C21 for indoor inhalation pathway since its saturated vapor concentration is significantly lower than that for other carbon fractions due to low solubility (0.65 mg/L). As shown in Table 1, the saturated vapor concentration for aromatics C16-C21 of 8.45 mg/m^3 is several orders of magnitude smaller than for other carbon fractions (3,500 mg/m^3 and 307 mg/m^3 for aromatics C10-C12 and aromatics C12-C16, respectively). Therefore, the risk for aromatics C16-C21 will be significantly lower than for the other carbon fractions assuming toxicity value is lower or same.

8. Of the remaining seven carbon fractions, the following five carbon fractions resulted in (i) Tier 1 risk-based target levels (RBTLs) of subsurface soil greater than saturated soil concentration, and (ii) Tier 1 RBTLs of groundwater greater than solubility values (Appendix B of the MDNR, April 2006):

   - Aliphatics C6-C8
   - Aliphatics C10-C12
   - Aliphatics C12-C16
   - Aromatics C10-C12
   - Aromatics C12-C16

   This indicates that these five carbon fractions are not a concern for indoor inhalation pathway even if LNAPL were present.

9. Based on the above, two carbon fractions (aliphatics C8-C10 and aromatics C8-C10) are of concern for indoor inhalation pathway within the MRBCA process.

TPH Application at Boeing Site

At the Boeing site, the risk calculations (RAM Group, September 2004) followed the draft MRBCA process (at the time under development). The results indicated non-carcinogenic risk exceedences due to indoor inhalation of TPH only in groundwater. Table 2 presents the cumulative hazard index (HI) and chemicals showing exceedences for indoor inhalation pathway.

The risks due to TPH for indoor inhalation pathway were estimated as below:

1. Groundwater samples collected from 1998 to May 2004 were reported as various TPH products, e.g., gasoline, volatile petroleum hydrocarbons, No. 6 fuel oil, diesel #1, kerosene, stoddard solvent, and motor oil. The samples were analyzed using different methods. Professional judgment was used to assign them to TPH-GRO, TPH-DRO, and TPH-ORO groups.

   For example, gasoline and volatile petroleum hydrocarbons were assigned to

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TPH-GRO; No.6 fuel oil, diesel #1, kerosene, and stoddard solvent were assigned to TPH-DRO; and motor oil was assigned to TPH-ORO.

2. To estimate risks, the concentration of TPH groups (TPH-GRO, TPH-DRO, and TPH-ORO) had to be assigned to each aliphatics and aromatics carbon fraction. This assignment was based on about 10 samples collected in April 2004 and analyzed for TPH groups (Method TX1005) and carbon fractions (Method TX1006).

   For example, Sub-area 6C had TPH groups and carbon fractions data from two samples (B27E2 and B27I9) collected in April 2004. The average carbon fraction ratios of two samples were used to calculate groundwater concentration of each carbon fraction. Table 3 presents the ratios and concentrations of carbon fraction for Sub-area 6C.

   For the areas/sub-areas without carbon fractions data, concentrations of TPH groups were distributed equally among the carbon fractions.

3. Inhalation toxicity values which are identical for all the aliphatics carbon fractions (except for aliphatics C6-C8) and for all the aromatics were used to calculate the risks.

4. As discussed in item no. 6 and 7 under TPH Methodology in MRBCA process, the calculation of risk due to four non-volatile carbon fractions are not appropriate. If the risk for these four non-volatile carbon fractions were not considered, the cumulative risk of four sub-areas (3G, 6B, 6C, and 8B) would not exceed the regulatory acceptable risk level. This correction still result in risk exceedences in five sub-areas (2A, 2B, 3A, 3C, 3E).

5. For the risk calculations, the representative groundwater concentrations of carbon fractions were not capped at the solubility levels. The representative groundwater concentrations used are presented in Table 4(a) and are compared with the solubility values of carbon fractions. Note the representative groundwater concentrations of aliphatic fractions are several orders of magnitude higher than the solubility values obtained from the MDNR (April, 2006). These representative groundwater concentrations resulted in the estimated vapor concentrations exceeding the saturated vapor concentrations (Table 4(b)). Clearly, this is not correct and over-estimates risks.

   To correctly account for the solubility values, the risks for indoor inhalation of vapors from groundwater were updated using the solubility levels of carbon fractions. Table 5 summarizes the cumulative HIs in the RAM Group (September 2004) and the cumulative HIs updated using the solubility values. The results indicate that if the solubility values were used, the cumulative risks are acceptable for all the areas/sub-areas.

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We believe that at the Boeing site, the risks due to TPH for indoor inhalation pathway were over-estimated and the risk exceedences due to TPH for indoor inhalation pathway are due to an artifact of the manner in which the risks from TPHs were calculated following draft MRBCA process.

References

MDNR, January 2004. MRBCA Process for Petroleum Storage Tanks.

MDNR, April 2006. Departmental Missouri Risk-Based Corrective Action (MRBCA) Technical Guidance.

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If you have any questions, please let us know.

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Table 1

Toxicity Values and Physical/Chemical Properties for Inhalation Pathway
Boeing Tract 1, St. Louis, Missouri

Carbon Fraction	Inhalation Reference Dose, RfD_i (mg/kg-day)	Molecular Weight, MW (g/mol)	Henry's Law Constant, H (L-water/L-air)	Water Solubility, S (mg/L)	Saturated Soil Vapor Concentration, C_v^{sat} (mg/m^3)	Organic Carbon Adsorption Coefficient, K_{oc} (cm^3/g)	Diffusion Coefficient in Air, D_a (cm^2/s)	Diffusion Coefficient in Water, D_w (cm^2/s)
TPH-GR0								
Aliphatics - > C6-C8	5.3E+00	100	5.00E+01	5.40E+00	2.70E+05	3.98E+03	1.00E-01	1.00E-05
Aliphatics - > C8-C10	2.9E-01	130	8.00E+01	4.30E-01	3.44E+04	3.16E+04	1.00E-01	1.00E-05
Aromatics - >C8-C10	5.7E-02	120	4.80E-01	6.50E+01	3.12E+04	1.58E+03	1.00E-01	1.00E-05
TPH-DR0								
Aliphatics - >C10-C12	2.9E-01	160	1.20E+02	3.40E-02	4.08E+03	2.51E+05	1.00E-01	1.00E-05
Aliphatics - >C12-C16	2.9E-01	200	5.20E+02	7.60E-04	3.95E+02	5.01E+06	1.00E-01	1.00E-05
Aliphatics - >C16-C21	NA	270	4.90E+03	2.50E-06	1.23E+01	6.31E+08	1.00E-01	1.00E-05
Aromatics - >C10-C12	5.7E-02	130	1.40E-01	2.50E+01	3.50E+03	2.51E+03	1.00E-01	1.00E-05
Aromatics - >C12-C16	5.7E-02	150	5.30E-02	5.80E+00	3.07E+02	5.01E+03	1.00E-01	1.00E-05
Aromatics - >C16-C21	NA	190	1.30E-02	6.50E-01	8.45E+00	1.58E+04	1.00E-01	1.00E-05
TPH-ORO								
Aliphatics - >C21-C35	NA	270	4.90E+03	2.50E-06	1.23E+01	6.31E+08	1.00E-01	1.00E-05
Aromatics - >C21-C35	NA	240	6.70E-04	6.60E-03	4.42E-03	1.26E+05	1.00E-01	1.00E-05

Notes:
NA: Not available

Table 2

Cumulative Hazard Index and Chemicals with Exceedences for Indoor Inhalation Pathway
Boeing Tract 1, St. Louis, Missouri

Sub-area	Cumulative HI	Chemical with Exceedence	HQ for Indoor Inhalation from Groundwater
2A	22	TPH-GRO	3.4
		TPH-DRO	18.9
2B	96	Aliphatics C12 - C16	7.1
		Aliphatics C16 - C21	78.6
		Aliphatics C21 - C35	9.3
3A	2.6	TPH-DRO	1.7
3C	77	TPH-DRO	58
		TPH-ORO	19
3E	10	Aliphatics C16 - C21	8.6
3G	2.8	Aliphatics C21 - C35	2.8
6B	7.9	Aliphatics C16 - C21	6.9
6C	4.1	Aliphatics C16 - C21	2.2
		Aliphatics C21 - C35	1.1
8B	55	Aliphatics C16 - C21	30
		Aliphatics C21 - C35	24

Notes:
HI: Hazard index
HQ: Hazard quotient

Table 3

Ratios and Concentrations of Carbon Fractions in Groundwater

Boeing Tract 1, St. Louis, Missouri

Carbon Fraction	Sub-area 6C		Average Ratio	Average Conc × Ratio
	B27E2W	B27I9W		
TPH-ORO (Average Concentration)				*1022*
Aliphatics >nC21 to nC35 (TX1006)	250	3000		727
Aromatics >nC21 to nC35 (TX1006)	250	250		295
Total TPH-ORO	**500**	**3250**		
Ratio of Aliphatics >nC21 to nC35 (TX1006)/Total TPH-ORO	0.50	0.92	0.71	
Ratio of Aromatics >nC21 to nC35 (TX1006)/Total TPH-ORO	0.50	0.08	0.29	
TPH-DRO (Average Concentration)				*12575*
Aliphatics >nC10 to nC12 (TX1006)	250	250		1497
Aliphatics >nC12 to nC16 (TX1006)	250	2000		4641
Aliphatics >nC16 to nC21 (TX1006)	250	250		1497
Aromatics >nC10 to nC12 (TX1006)	250	250		1497
Aromatics >nC12 to nC16 (TX1006)	250	500		1946
Aromatics >nC16 to nC21 (TX1006)	250	250		1497
Total TPH-DRO	**1500**	**3500**		
Ratio of Aliphatics >nC10 to nC12 (TX1006)/Total TPH-DRO	0.17	0.07	0.12	
Ratio of Aliphatics >nC12 to nC16 (TX1006)/Total TPH-DRO	0.17	0.57	0.37	
Ratio of Aliphatics >nC16 to nC21 (TX1006)/Total TPH-DRO	0.17	0.07	0.12	
Ratio of Aromatics >nC10 to nC12 (TX1006)/Total TPH-DRO	0.17	0.07	0.12	
Ratio of Aromatics >nC12 to nC16 (TX1006)/Total TPH-DRO	0.17	0.14	0.15	
Ratio of Aromatics >nC16 to nC21 (TX1006)/Total TPH-DRO	0.17	0.07	0.12	
TPH-GRO (Average Concentration)				*203*
Aliphatics > nC6 to nC8 (TX1006)	1500	250		110
Aliphatics >nC8 to nC10 (TX1006)	250	250		47
Aromatics >nC8 to nC10 (TX1006)	250	250		47
Total TPH-GRO	**2000**	**750**		
Ratio of Aliphatics > nC6 to nC8 (TX1006)/Total TPH-GRO	0.75	0.33	0.54	
Ratio of Aliphatics >nC8 to nC10 (TX1006)/Total TPH-GRO	0.13	0.33	0.23	
Ratio of Aromatics >nC8 to nC10 (TX1006)/Total TPH-GRO	0.13	0.33	0.23	

Note:

All concentrations are in micrograms per liter (ug/L)

Table 4(a)

Comparison of TPH Groundwater Representative Concentrations with Solubility

Boeing Tract 1, St. Louis, Missouri

TPHs	Solubility (ug/L)	Sub-area 2A		Sub-area 2B		Sub-area 3A		Sub-area 3C		Sub-area 3E	
		Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility
TPH-GRO		**5.55E+05**		**2.95E+04**		**1.06E+03**		**5.71E+04**		**2.95E+04**	
Aliphatics > nC6 to nC8	5.40E+03	1.85E+05	34	4.92E+03	0.9	3.53E+02	0.1	1.90E+04	3.5	4.92E+03	0.9
Aliphatics > nC8 to nC10	4.30E+02	1.85E+05	430	4.92E+03	11	3.53E+02	0.8	1.90E+04	44	4.92E+03	11
Aromatics > nC8 to nC10	6.50E+04	1.85E+05	2.8	1.97E+04	0.3	3.53E+02	0.01	1.90E+04	0.3	1.97E+04	0.3
TPH-DRO		**9.52E+04**		**5.00E+04**		**6.98E+03**		**2.40E+05**		**5.00E+04**	
Aliphatics > nC10 to nC12	3.40E+01	1.59E+04	466	8.34E+03	245	1.16E+03	34	4.01E+04	1,179	8.34E+03	245
Aliphatics > nC12 to nC16	7.60E-01	1.59E+04	20,867	8.34E+03	10,970	1.16E+03	1,531	4.01E+04	52,734	8.34E+03	10,970
Aliphatics > nC16 to nC21	2.50E-03	1.59E+04	6,343,667	8.34E+03	3,335,000	1.16E+03	465,533	4.01E+04	16,031,133	8.34E+03	3,335,000
Aromatics > nC10 to nC12	2.50E+04	1.59E+04	0.6	8.34E+03	0.3	1.16E+03	0.05	4.01E+04	1.6	8.34E+03	0.3
Aromatics > nC12 to nC16	5.80E+03	1.59E+04	2.7	8.34E+03	1.4	1.16E+03	0.2	4.01E+04	6.9	8.34E+03	1.4
Aromatics > nC16 to nC21	6.50E+02	1.59E+04	24	8.34E+03	13	1.16E+03	1.8	4.01E+04	62	8.34E+03	13
TPH-ORO		**2.88E+02**		**4.85E+03**		**1.45E+03**		**2.96E+04**		**4.85E+03**	
Aliphatics > nC21 to nC35	2.50E-03	1.44E+02	57,500	3.73E+02	149,231	7.25E+02	289,800	1.48E+04	5,913,800	3.73E+02	149,231
Aromatics > nC21 to nC35	6.60E+00	1.44E+02	22	4.48E+03	678	7.25E+02	110	1.48E+04	2,240	4.48E+03	678

Notes:

ug/L: Micrograms per liter

Ratio > 1: Rep. conc. higher than solubility

Rep. Conc.: Representative concentration

Table 4(a)

Comparison of TPH Groundwater Representative Concentrations with Solubility

Boeing Tract 1, St. Louis, Missouri

TPHs	Solubility (ug/L)	Sub-area 3G		Sub-area 6B		Sub-area 6C		Sub-area 8B	
		Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility	Rep. GW Conc.	Ratio of Rep. Conc./ Solubility
TPH-GRO		**5.04E+03**		**9.96E+02**		**2.03E+02**		**2.50E+02**	
Aliphatics > nC6 to nC8	5.40E+03	1.68E+03	0.3	8.85E+02	0.2	1.10E+02	0.02	8.33E+01	0.02
Aliphatics > nC8 to nC10	4.30E+02	1.68E+03	3.9	5.53E+01	0.1	4.65E+01	0.1	8.33E+01	0.2
Aromatics > nC8 to nC10	6.50E+04	1.68E+03	0.03	5.53E+01	0.001	4.65E+01	0.001	8.33E+01	0.001
TPH-DRO		**2.00E+03**		**3.35E+04**		**1.26E+04**		**4.95E+04**	
Aliphatics > nC10 to nC12	3.40E+01	2.22E+02	6.5	5.58E+03	164	1.50E+03	44	4.67E+02	14
Aliphatics > nC12 to nC16	7.60E-01	8.89E+02	1,170	5.58E+03	7,336	4.64E+03	6,106	9.34E+03	12,289
Aliphatics > nC16 to nC21	2.50E-03	2.22E+02	88,889	5.58E+03	2,230,067	1.50E+03	598,810	2.80E+04	11,207,547
Aromatics > nC10 to nC12	2.50E+04	2.22E+02	0.01	5.58E+03	0.2	1.50E+03	0.1	4.67E+02	0.02
Aromatics > nC12 to nC16	5.80E+03	2.22E+02	0.04	5.58E+03	1.0	1.95E+03	0.3	3.74E+03	0.6
Aromatics > nC16 to nC21	6.50E+02	2.22E+02	0.3	5.58E+03	8.6	1.50E+03	2.3	7.47E+03	11
TPH-ORO		**3.04E+03**		**1.50E+02**		**1.02E+03**		**3.20E+04**	
Aliphatics > nC21 to nC35	2.50E-03	2.43E+03	972,800	7.50E+01	30,000	7.27E+02	290,877	2.29E+04	9,142,857
Aromatics > nC21 to nC35	6.60E+00	6.08E+02	92	7.50E+01	11	2.95E+02	45	9.14E+03	1,385

Notes:

ug/L: Micrograms per liter

Ratio > 1: Rep. conc. higher than solubility

Rep. Conc.: Representative concentration

Table 4(b)

Comparison of TPH Soil Vapor Concentrations with Saturated Soil Vapor Concentrations

Boeing Tract 1, St. Louis, Missouri

TPHs	Saturated Vapor Concentation (mg/m^3)	Sub-area 2A		Sub-area 2B		Sub-area 3A		Sub-area 3C		Sub-area 3E	
		Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.
TPH-GRO		**2.41E+07**		**6.49E+05**		**4.61E+04**		**2.48E+06**		**6.49E+05**	
Aliphatics > nC6 to nC8	2.70E+05	9.25E+06	34	2.46E+05	0.9	1.77E+04	0.1	9.51E+05	3.5	2.46E+05	0.9
Aliphatics > nC8 to nC10	3.44E+04	1.48E+07	430	3.93E+05	11	2.83E+04	0.8	1.52E+06	44	3.93E+05	11
Aromatics > nC8 to nC10	3.12E+04	8.88E+04	2.8	9.44E+03	0.3	1.70E+02	0.01	9.13E+03	0.3	9.44E+03	0.3
TPH-DRO		**8.79E+07**		**4.62E+07**		**6.45E+06**		**2.22E+08**		**4.62E+07**	
Aliphatics > nC10 to nC12	4.08E+03	1.90E+06	466	1.00E+06	245	1.40E+05	34	4.81E+06	1,179	1.00E+06	245
Aliphatics > nC12 to nC16	3.95E+02	8.25E+06	20,867	4.34E+06	10,970	6.05E+05	1,531	2.08E+07	52,734	4.34E+06	10,970
Aliphatics > nC16 to nC21	1.23E+01	7.77E+07	6,343,667	4.09E+07	3,335,000	5.70E+06	465,533	1.96E+08	16,031,133	4.09E+07	3,335,000
Aromatics > nC10 to nC12	3.50E+03	2.22E+03	0.6	1.17E+03	0.3	1.63E+02	0.05	5.61E+03	1.6	1.17E+03	0.3
Aromatics > nC12 to nC16	3.07E+02	8.41E+02	2.7	4.42E+02	1.4	6.17E+01	0.2	2.12E+03	6.9	4.42E+02	1.4
Aromatics > nC16 to nC21	8.45E+00	2.06E+02	24	1.08E+02	13	1.51E+01	1.8	5.21E+02	62	1.08E+02	13
TPH-ORO		**7.04E+05**		**1.83E+06**		**3.55E+06**		**7.24E+07**		**1.83E+06**	
Aliphatics > nC21 to nC35	1.23E+01	7.04E+05	57,500	1.83E+06	149,231	3.55E+06	289,800	7.24E+07	5,913,800	1.83E+06	149,231
Aromatics > nC21 to nC35	4.42E-03	9.63E-02	22	3.00E+00	678	4.85E-01	110	9.91E+00	2,240	3.00E+00	678

Notes:

mg/m^3: Milligrams per cubic meter

Ratio > 1: Estimated soil vapor concentration higher than saturated soil vapor concentration

Cocn.: Concentration

Table 4(b)

Comparison of TPH Soil Vapor Concentrations with Saturated Soil Vapor Concentrations

Boeing Tract 1, St. Louis, Missouri

TPHs	Saturated Vapor Concentation (mg/m^3)	Sub-area 3G		Sub-area 6B		Sub-area 6C		Sub-area 8B	
		Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m^3)	Ratio of Estimated/ Saturated Vapor Conc.	Estimated Vapor Conc. (mg/m3)	Ratio of Estimated/ Saturated Vapor Conc.
TPH-GRO		**2.19E+05**		**4.87E+04**		**9.24E+03**		**1.09E+04**	
Aliphatics > nC6 to nC8	2.70E+05	8.40E+04	0.3	4.43E+04	0.2	5.50E+03	0.02	4.17E+03	0.02
Aliphatics > nC8 to nC10	3.44E+04	1.34E+05	3.9	4.43E+03	0.1	3.72E+03	0.1	6.67E+03	0.2
Aromatics > nC8 to nC10	3.12E+04	8.06E+02	0.03	2.66E+01	0.001	2.23E+01	0.001	4.00E+01	0.001
TPH-DRO		**1.58E+06**		**3.09E+07**		**9.93E+06**		**1.42E+08**	
Aliphatics > nC10 to nC12	4.08E+03	2.67E+04	6.5	6.69E+05	164	1.80E+05	44	5.60E+04	14
Aliphatics > nC12 to nC16	3.95E+02	4.62E+05	1,170	2.90E+06	7,336	2.41E+06	6,106	4.86E+06	12,289
Aliphatics > nC16 to nC21	1.23E+01	1.09E+06	88,889	2.73E+07	2,230,067	7.34E+06	598,810	1.37E+08	11,207,547
Aromatics > nC10 to nC12	3.50E+03	3.11E+01	0.01	7.81E+02	0.2	2.10E+02	0.1	6.54E+01	0.02
Aromatics > nC12 to nC16	3.07E+02	1.18E+01	0.04	2.95E+02	1.0	1.03E+02	0.3	1.98E+02	0.6
Aromatics > nC16 to nC21	8.45E+00	2.89E+00	0.3	7.25E+01	8.6	1.95E+01	2.3	9.71E+01	11
TPH-ORO		**1.19E+07**		**3.68E+05**		**3.56E+06**		**1.12E+08**	
Aliphatics > nC21 to nC35	1.23E+01	1.19E+07	972,800	3.68E+05	30,000	3.56E+06	290,877	1.12E+08	9,142,857
Aromatics > nC21 to nC35	4.42E-03	4.07E-01	92	5.03E-02	11	1.98E-01	45	6.13E+00	1,385

Notes:

mg/m^3: Milligrams per cubic meter

Ratio > 1: Estimated soil vapor concentratio

Cocn.: Concentration

Table 5
Summary of Cumulative Hazard Index
Boeing Tract 1, St. Louis, Missouri

Sub-area	Cumulative HI	
	2004 RA	Updated with Carbon Fraction Solubility
2A	22	0.057
2B	96	0.75
3A	2.6	0.07
3C	77	0.064
3E	10	0.079
3G	2.8	0.052
6B	7.9	0.063
6C	4.1	0.071
8B	55	0.053

Note:
HI: Hazard index
RA: Risk assessment (RAM Group, Sepbember 2004)